

Science Curriculum Implementation in Botswana

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ABSTRACT

This study set out to explore the implementation of a new integrated science curriculum in Community Junior Secondary Schools (CJSS) in Botswana. The research sample consists of 26 science teachers in eight schools in one location 50-60 km from Gaborone, the capital city. The main purpose of and justification for the qualitative case study is that it attempts to identify, relate and explain daily experiences and activities in the use of the curriculum during its establishment phase.

The findings of the study demonstrate two key areas of importance to curriculum implementation. The first concerns the finding that there were conflicting messages in and about the curriculum. This is in respect of the use of attainment targets (i.e., instructional objectives), obsolete text-books and content-oriented mock examinations to "define" the curriculum. The question thus arose as to whether the change was about *maintenance* of an academic curriculum or *change* to relevant education. The other concern arose from the conflict inherent in the goals of the curriculum which sought to cater for a very broad group of mixed ability pupils enrolled into CJSS mostly through automatic promotion and not through merit.

Another area of importance is the management of change. The Ministry had been widely expected to play a leading role in the guidance and establishment of curriculum change. That did not happen, which placed the professional status and occupational roles of teachers under threat because they tended to see their roles as carrying relatively low power or little authority to support curriculum implementation. Moreover, the organisational climate in schools was unsupportive to teachers who operated as individuals.

Overall, the study showcases the importance of the management of change and the implications of the wider ecological contexts to the success of curriculum implementation.

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DECLARATION

I, Anthony Tsatsing Koosimile, hereby certify that I am the author of this work except in places where reference is made to other writers. The work has never been submitted to any institution for any award.

Signed,

A. T. KOOSIMILE

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CHAPTER 1

BACKGROUND TO THE STUDY

This work is about the implementation of a science curriculum in Community Junior Secondary Schools (CJSS) in Botswana. The case study, involving 26 science teachers, utilised classroom observations and unstructured interviews as the main modes of data collection. The one-year fieldwork started in September 1997, 18 months after the curriculum was introduced into schools. The work closely examines curriculum change during its phase of establishment, and is acknowledged to have been performed in a highly transitional phase early in the life of the curriculum. But, the research findings and outcomes are naturally believed to be important in various ways, including, providing a reference point or benchmark against which future researchers can compare their findings or seek further understanding of the curriculum. The work is important to teachers and anyone else concerned with curriculum development and teacher training in Botswana in particular, and in developing countries in general.

A comprehensive overview of the education system in Botswana, educational change and policy formulation, and curriculum development is contained in Appendix 1. The Appendix sets a context and background for understanding the curriculum whose implementation is the focus of this study. The first section of this chapter presents a background of secondary school education. It highlights the key aspects of the education system. The second section explains certain key concepts used throughout the study. The nature of the science curriculum is presented in the third section of the chapter. Its foci are the key curriculum features which form the basis for understanding its implementation. The fourth section comprises clear statements for the problem of investigation, the purpose of and rationale for the study. An outline of the structure of the work concludes the chapter.

1.1.0 Background to Secondary Education in Botswana

Until 1986, the education pattern comprised seven years of primary school education followed by three years of junior secondary and two of years senior secondary education leading to O-level qualification (i.e., Cambridge Overseas School Certificate, COSC). Primary school education leads to a Primary School Leaving Certificate (PSLC), while junior secondary leads to a Junior Certificate (JC) in education. The configuration is commonly called the 7-3-2 system. From 1986 to December 1995, the pattern was 7-2-3 which had been expected to change to 6-3-3 in 1990 (Republic of Botswana, 1977, p. 239) as part of the wider reforms in education. The change never materialised, and a 7-3-2 system has been in place since January 1996.

Motivation for the changes derived from the recommendations of the National Commission on Education of 1976 (NCE-1976) (see Appendix 1) which was a body established by the Government of Botswana to examine the then widespread disquiet concerning the quality of education in Botswana (Kahn, 1989; Prophet, 1990). One of the recommendations of the NCE-1976 was to restructure both the curricula of primary school and junior secondary education to be jointly and collectively offered as a "Basic Education" package. This meant that the scope of basic education was redefined and broadened. Furthermore, the Commission wanted education to achieve greater equity, efficiency (Kahn, 1989) and equality (ibid., Prophet, 1990) within and between regions and within the socio-economic realities of Botswana. These were to be achieved through a state-run centralised education system by the removal of schooling age restrictions and by the abolition of school fees in all state schools.

In contrast, pre-1986 basic education terminated at primary school. There was also a highly disproportionate number of primary schools (528 in 1985) to 42 junior secondary schools (Central Statistics Office, 1995, p. 4). Tuition fees for secondary schools were almost 20-30 times higher than those for primary schools, taking education out of the reach of most families. Following the NCE-1976, universal access to basic education was declared a basic right for the youth in Botswana. This affected the educational set-up as explained in the two sections below. These sections consider the key aspects of basic education. The infrastructure provided for basic education is considered first followed by locating, through an overview, basic education in the development of youth in Botswana.

1.1.1 Infrastructure for basic education

The new concept of basic education necessitated the rapid expansion of Community Junior Secondary Schools (CJSS), purpose-built for offering junior secondary education only. Primary schools retained their identity. The CJSS are built through a joint partnership between the government and the community which the schools will serve (Moorad, 1990; Central Statistics Office, 1995). The government bears a large proportion of the costs of construction and operation of the CJSS; the community provides staff accommodation and pays ancillary staff (Republic of Botswana, 1985, p. 144) though the cost has been so prohibitive for communities that the projects and their maintenance are now taken over almost exclusively by the government. The partnership also symbolises the government's wish to make schools integral to the community they serve so they are not isolated institutions (Ministry of Education, 1984; Swartland and Taylor, 1987). An informative account of the earlier versions and genre of community schools and community involvement in education in Botswana has been written by Swartland and Taylor (1987). The account is not repeated here.

A major upgrading of the CJSS sector was initiated in the National Development Plan period running from 1985-91. All CJSS, new and old, come as a complete package comprising a library

designed both for studying and for teaching purposes; two science laboratories; a multipurpose block for the teaching of Home Economics, Technical Studies; classrooms; staffrooms; teachers quarters; and essential services such as electricity and water. In 1998, there were 230 CJSS (McDevitt, 1998) against 20 in 1983; 97 in 1989; 149 in 1991; and 163 in 1993 (Central Statistics Office, 1995, p. 4). This, combined with automatic promotion of pupils from primary to CJSS and the notion of universal access to Form 1, resulted in 1993 in a progression rate of more than 80% (Central Statistics Office, 1993; Republic of Botswana, 1993; Mautle *et al.*, 1993) between the two levels of basic education. In terms of the actual number of pupils involved, The National Commission on Education of 1993 (NCE-1993) provides the following picture:

About 93% of pupils who sat PSLE (i.e., Primary School Leaving Examinations) in 1992 were admitted to Form 1 in 1993. The total number that took the examination was 36 919 against 36 270 Form 1 places. This means that almost 100% access could have been achieved had the geographical distribution of Form 1 places matched that of students. In 1993, it is estimated that about 39 000 pupils will take the PSLE and that the number of Form 1 places that will be available is 39 450. Therefore it is now possible to achieve 100% access within the current two year JC structure. However, this progression rate will be negatively affected by the recommendation to extend the JC to three years if additional facilities are not provided (Republic of Botswana, 1993, p. 151).

The progression rate is indeed symbolic regarding conceptualisation and operationalisation of the ideals of basic education.

The expansion of schools was also accompanied by the opening of two Colleges of Education in Molepolole in 1985 and in Tonota in 1990 (*ibid.*, p. 142) for training teachers for CJSS. A training institute for primary school teachers was built in Tlokweng to add to the three existing at the time. Today, Botswana has more than 600 primary schools, 230 junior secondary schools, 28 senior secondary schools, a university, five teacher training colleges, and several other vocational institutions. Within such an elaborate establishment, basic education occupies a position which can best be understood in terms of political and socio-economic factors governing the provision of education (see Appendix 1). An overview of basic education is provided here as a background against which changes in policy in education since NCE-1976 can be understood.

1.1.2 Overview of basic education

A further understanding of the position of basic education in Botswana is found in the fact that senior secondary education remained qualitatively unchanged until 1996 despite changes in both primary and junior secondary school education. The number of senior secondary schools remained relatively unchanged despite the massive expansion of the CJSS. This was a policy issue aimed at deliberately restricting access to 'academic and elite' education (Republic of Botswana, 1993). Senior secondary education, offering the Cambridge Overseas "O" level subjects, in standing detached from basic education, accentuated the distinctiveness of basic education.

The basic education programme targets the youth and keeps them in school until their early teens (ages 15-16 years). This is achieved through a highly accommodating framework which places low emphasis on academic performance through the use of automatic promotion within schools and across the two levels of basic education. Secondly, basic education aims to take pupils beyond basic numeracy and literacy levels which previously could only be achieved through primary school education. At the end of basic education, pupils are two years away from tertiary education (including university education), while some go directly into vocational training. As Sinclair and Lillis (1980, p. 16) have observed, basic education here is the effective period of mass education in a particular country's formal education system.

However, as NCE-1993 noted, there are highly restricted opportunities for vocational training which in 1992 absorbed only 11% of drop-outs while senior secondary education took 27% of the cohort group. Sixty-two per cent of the group became school drop-outs (see also Tournas, 1996). Although the figures are outdated, they show a high attrition rate in school enrolments after basic education. Also, while more CJSS' were built between 1993 and 1996, the number of vocational centres and senior secondary schools remained relatively fixed. The progression rate to senior secondary was thus expected to decline to 25% by the end 1997 (Republic of Botswana, 1993, p. 167). The high attrition rate at the end of the basic education further defines the position of CJSS in the education system of the country.

Having given a brief overview of the education system, the next section focuses on some of the key concepts used in this work.

1.2.0 Key Concepts in this Work

Three concepts are widely used throughout this study. There are: curriculum, implementation and change. Each concept is used variously in the literature depending upon context. Here the respective interpretations of the terms are presented and they should be interpreted in this way except where indicated otherwise.

Curriculum is a concept that has a rather long history in education. Hamilton (1990) painstakingly traces the origins of the concept and locates its definition in an historical context. The history is not recounted here. His statement that a curriculum is "an ordered or structured entity" and that "it is more than a cluster of educational topics" (p. 41) hints at the plurality of meanings contained in the concept. Levy (1993) defines curriculum as:

... a concept spanning the production and control of knowledge, its delivery, structuring and exchange, within a wider socio-political and socio-economic context. Curriculum is not merely syllabus although it includes the syllabus (p. 159).

What is important in the definition is the fact that it views curriculum as something delivered within wider socio-political and socio-economic contexts. This suggests the unpredictability of the environments in which the curriculum is to be implemented. By implication, the form it takes depends on the wider context and, hence, different contexts have differing curricula.

A further understanding of the meaning of curriculum is based on Orpwood's (1985) position. In viewing curriculum as having both a rational and political character, Orpwood argues that it is a "type of policy - a plan, rule, or guide concerning what shall be taught where, when, and how" (p. 479). As a rational entity, he states the contents of the curriculum should be rationally defensible; it is also political in the sense that "it should represent commitments on the part of certain individuals to act in a certain way" (p. 479). A "conventional view of policy", states Jansen (1995), "is that it is a summary statement of vision, values, goals, i.e., a declaration of intent" (p. 338). Taken together, and bearing in mind the background of curriculum development in Botswana, curriculum here is taken as almost synonymous with a policy for the education of the youth and nation founded on both rational and political considerations. So this study is about policy implementation in Botswana with specific and exclusive focus on science teaching at CJSS level.

Implementation is taken to mean various forms of attempts by users (teachers and pupils) of curriculum to transform policy-makers' rhetoric and materials into classroom practice (cf. Tamir, 1980; Ball and Bowe, 1992). More clearly, "implementation refers to what really happens in practice as distinct from what was supposed to happen" (Fullan, 1982, p. 6). The process of implementation is not straightforward, as implementors make modifications and adaptations in light of different sets of priorities, preoccupations and interests (Saunders, 1985, pp. 1-2).

This is commonly referred to as curriculum-in-action. It has several discernible levels which are: perceived curriculum (especially by teachers); operational (actual instructional process in classroom); experiential (reaction and outcomes of learners); and attained curriculum (learning outcomes) (Goodlad *et al.*, 1979; Orpwood, 1985). The four, relating to interaction of users with curriculum materials, are distinct from the ideal and formal curriculum which refer to the curriculum as seen from the policy-makers' view and as contained in "official" documents and other support materials (*ibid.*).

However, at the level of implementation or use of curriculum materials, another dimension of curriculum becomes manifest. Curriculum here embraces all science concepts, knowledge, skills, and attitudes integral to the subject; the diverse modes of teaching/learning the subject within a school; and all the social and physical elements, conditions, and resources comprising the teaching/learning environment (Earley and Fletcher-Campbell, 1989, p. 129). This definition

would therefore incorporate the "hidden curriculum" (ibid.). This broad meaning is consistent with views presented above and only explicates the inclusive nature of the concept.

The term *change* is preferred to *innovation* in this work. Apart from the various conceptual difficulties in defining *innovation* (see Huberman, 1979; Bolam, 1975; OECD, 1973), the history of the development of science curriculum in Botswana does not seem to suggest fundamental and radical diversions from the philosophy of the Scottish Integrated Science curriculum of the 1970's. The word *innovation* seems inappropriate on those grounds. However, *change* is defined and used rather loosely "as a generic term embracing a family of concepts such as innovation, development, [and] renewal" (Bolam, 1975, p. 6). The history of curriculum change is detailed in Appendix 1. The next section gives a brief general overview of the science curriculum whose implementation is the focus of this work.

1.3.0 The Current Science Curriculum.

This two-part section is based on information from the syllabus document of the curriculum. My visits to the Curriculum Development Unit in the Ministry of Education in December 1998 failed to yield more documents to aid understanding of the nature of the curriculum. The first section covers general information about the curriculum, while the discussion of the nature of the curriculum is made in the other section.

The current science curriculum was first used in junior secondary schools in January 1996. It forms part of the core curriculum comprising five other subjects namely, English, Mathematics, Setswana, Social Studies, and Agriculture. They are all part of an elaborate five-year phased-in implementation of the basic education curriculum which started in January 1996 and with complete implementation expected in January to December 2000. Appendix 2 carries a full implementation plan. January 1996 - December 1998 comprised phase 1; 1999 is phase 2 and January 2000 will mark the beginning of the third and final phase. Various subject electives are selected at different phases, affecting loads for both teachers and pupils. These factors, including time allocations for each subject are fully covered in the Appendix.

The curriculum was developed by a Task Force (see Appendix 3) under the auspices of the Curriculum Development Unit of the Ministry of Education. It was developed as part of a new school curriculum package conceived with the intention of implementing some NCE-1993 recommendations. As observed in Appendix 1, the Commission did not seek to change the philosophy of the education system established in 1977 by its predecessor. So, the new curriculum materials were developed on similar philosophical assumptions and educational ideals as their predecessors. However, the current science curriculum in junior secondary schools is referred to as:

- (a) *Integrated Science*. For instance, in several official documents (see Republic of Botswana, 1993, p. 154 & 157). The use of the term dates back to the late 1960's and early 1970's at which latter date the Scottish Education Integrated Science Scheme was modified for use in Botswana. The latter was overtly called "Integrated Science" and was used in the schools until December 1995.
- (b) *Science* (Ministry of Education, 1995a). This is a non-committal and neutral stance which is maintained in the foreword to the Teachers' Guide of the current curriculum.

However, debates over the notion of integration and inconsistency in its use are prevalent in the literature (see Thier, 1973; Brown, 1977; Wellington, 1982; Ziman, 1980; Hodson, 1985; Lonning *et al.*, 1998). The word is in practice taken to be synonymous with *interdisciplinary* and *unified* (see Blum, 1981; McComas and Wang, 1998). "More often they appear as a sort of axiomatic definition, not to be discussed but applied", contends Arca and Vicentini-Missoni (1981, p. 118). However, discussion on integration issues will not be repeated here as they fall beyond the scope of this work. The title of a curriculum is nevertheless important as it may influence the manner of its use as well as the users' perceptions of it.

The next section provides an overview of the *science syllabus*, which term means a body of knowledge (facts, principles, skills) which form the substantive basis for curriculum content (Hamilton, 1982, p. 180).

1.3.1 The nature of the science curriculum

A copy of the syllabus document is included as Appendix 12 of this work. The aims listed in and a set of statements from the syllabus 'define' the curriculum and are treated in turn.

The seven aims of the curriculum are: "At the end of three years of Junior Secondary Science Programme, students are expected to have developed:

1. an understanding of the basic principles and concepts of science as they are experienced in everyday life.
2. positive attitudes towards scientific skills such as curiosity, open-mindedness, creativity, objectivity, integrity and initiative.
3. an ability to use process skills associated with the practice of science for understanding and exploring natural phenomena, problem-solving and decision-making.
4. an awareness and appreciation of the interrelationships between science, technology and society in the context of science and everyday life.
5. an awareness, literacy and understanding of the significance of computers in science-related careers.

6. the ability to and the responsibility of protecting the environment and of using natural resources on a sustainable basis.
7. the ability to make informed decisions about further studies and science-based careers and vocations." (Ministry of Education, 1995a, p. iii).

The aims of the syllabus bear hallmarks of a typical school science programme reflecting concerns with contemporary debates in science education and how it can enhance the quality of life of pupils. Aims 1, 2, 3 and 7 are consistent with the spirit of national development through the creation of a scientifically literate society which can bring science to bear, where possible, in various areas of human endeavour. The pivotal role of science in the development of industries, the improvement of social welfare, and in many spheres of decision-making in contemporary society seems to require little justification. Studying science concepts in everyday contexts is consistent with the notion of humanising science, promoting meaningful learning of the discipline in ways which are culturally and cognitively appropriate (cf. Ingle and Turner, 1981), as well as promoting the 'relevance' of science to both pupils and society. Matthews (1990) calls this a "contextualist" approach to science teaching. The latter brings into a science classroom the benefits of viewing the discipline as a social undertaking subject to various factors which are socio-economic, technological, ethical, and cultural in origin (ibid.).

Aims 4, 5 and 6 typify hallmarks of the current worldwide efforts to establish an understanding of science in its relation to society and technology. A number of exemplary science, society and technology schemes can be cited. They are: SISCON in Britain (see Solomon, 1985); PLON in Holland (see, e.g., Eykelhof and Kortland, 1985); America 2000 and Project 2061 in America (Rutherford and Ahlgren, 1990), and the UNESCO-initiated Project 2000+ (Holbrook, 1993), among others .

The following four statements provide a further understanding of the curriculum. **Statement 1** states that:

The syllabus offers learning opportunities targeted at addressing the broad intentions of the policy. To satisfy the expected outcomes, the syllabus focuses on the development of skills, attitudes, values, and knowledge students are expected to demonstrate by the time they complete the junior secondary course. The content has been selected from the students immediate environment to facilitate understanding and ease of transfer of skills and knowledge to real life situations (Ministry of Education, 1995a, foreword).

Parts of the above statement align the curriculum well with one of the recommendations of NCE-1976 which stated that education should aim to:

... provide all children with: ... an understanding of scientific and technical subjects, based on examples from their own environment; a sense on nature of their society and their role in it; ... an orientation toward work in the real world (Republic of Botswana, 1977, p. 6).

Statement 2

In stark contrast to its predecessor which openly advocated discovery learning and child-centred teaching methods (see Ministry of Education, 1986), there is neither a suggestion of, a specific mention of nor a reference to any particular teaching approach to be adopted in teaching the new curriculum. Instead, it is stated:

In teaching the syllabus, it should be realised that when children come to school, they come not with blank minds, but with some knowledge, attitudes and beliefs. Some of these experiences may become useful or inhibitive during teaching/learning process, and so teachers have to be aware of these earlier experiences to more effectively communicate understanding through recognising individual abilities, interests and needs (Ministry of Education, 1995a, p. i).

Statement 3

Although the syllabus does not make a clear commitment to the status of practical work in science teaching, teachers are informed that:

Science by its nature involves experimental activities characterised by inquiry methods of learning ... Children learn about objects and events by asking questions, investigating and experimenting to find answers. This scientific method of enquiry develops in children the skills and attitudes that facilitate learning of science and even other subjects (ibid.).

Statement 4

Furthermore,

Science learning ... should draw from and apply to living experiences in an effort to give children practical, relevant, and meaningful experiences in preparing them for living in a changing world (ibid., pp. i-ii)

It appears that the contemporary interactive-constructive perspective of teaching, in which the learner is the "doer" and "meaning maker" of the materials and the teacher is facilitator (cf. Digisi and Willett, 1995), is advocated. The constructivist perspective, with its allegiance to pupils' beliefs, values, attitudes, and norms, and with teachers being asked to be sensitive to the same, further affirms and strengthens the position that the ideal curriculum is intended to be context-driven. On the other hand, it is suggested that teaching should be practical and should include experiments as "hands-on" activities reinforce the *seemingly* natural scientific method of enquiry. The above provides a broad framework for teaching.

However, the curriculum has three noteworthy characteristics which mark a break from the past traditions in changes in science education in Botswana. Firstly, the curriculum appears to be outcomes-based wherein it is defined with a set of instructional objectives instead of with an explicit specification of scope and depth of content. There are 444 specific objectives using a total

of 40 action verbs spread across the ten-modules of the three-year programme. About 26% of them are at Bloom's knowledge level; 30% at comprehension level; while 27% are associated with the application stage. The remaining 17% is thinly scattered across the higher order levels of analysis, synthesis, and evaluation of the taxonomy. However, there are problems with relying exclusively on such categorisation as a basis for generating understanding of the nature of priorities within the course. This arises because the concern is on categorising the *action verbs* or *behaviour descriptors* and thereby on marginalising the context which provides an instructional objective with a meaning. On the contrary, if the whole instructional objective is analysed, variations in contexts where a particular *action verb* is used implies a change in the competency levels to be achieved.

Secondly, the syllabus demonstrates the marked influence of contemporary educational rhetoric with an emphasis on empowering citizens for the 21st century. As Reid (1975) says, it had become:

... apparent the critical task of educators was to equip children for an uncertain future and, consequently, that the central concern of curriculum planning must be to foster and facilitate change and not to refine instruments which tended to perpetuate the status quo (p. 242).

Illustrative examples are presented here as a way of enhancing the understanding of the nature of the curriculum. An attempt to introduce applications of scientific knowledge to daily life is made in those units where the knowledge is already overtly used in society. Examples include:

- (a) Methods of Heat Transfer and Applications (e.g., solar water heaters, vacuum flask, car engine cooling system);
- (b) The House (covering ventilation, insulation, and building materials in general);
- (c) Water treatment and purification systems (sedimentation, boiling and chemical methods);
- (d) Family Planning (birth control, prevention and treatment of sexually transmitted diseases, analysis of national statistics for communicable diseases);
- (e) Health (Nutrition and diseases)
- (f) Electricity; and,
- (g) Chemicals in the Home.

Naturally occurring phenomena and systems are also studied. Examples which fall into this category include: photosynthesis, respiration, ecosystems and food chains; air; the solar system; and earth's resources (mining and extraction of minerals). There is also an overt campaign to make pupils aware of contemporary topical issues impinging on mankind. These include issues such as HIV/AIDS, conservation of natural resources, and pollution. On the other hand, the overall profile of the curriculum reveals a concern with a multi-disciplinary approach to the study of concepts and

phenomena (i.e., "real-life examples"). One example suffices in illustrating the multi-disciplinary approach.

The example concerns the study of the concept of Matter. A distinctly physics-based but basic theoretical background to defining *matter* is undertaken prior to presenting, in the same unit in Year 1, the *Living Matter* which is distinctly Biology. In the second year of the programme, pupils' understanding of Matter is promoted from a chemistry-based perspective through the study of air (carbon dioxide and oxygen). Atomic structure, Acids and Bases, Metals and Non-Metals, are studied in the third-year of the syllabus. Rather than merely building on previous knowledge from first- and second-years of the syllabus, an attempt is also made to broaden pupils' knowledge-base and understanding of *Matter* over time. Teaching on Purification techniques, mineral extraction, importance of air to life are important not only in highlighting the various applications of the concept of matter in science but also in showing their benefit to humanity. In general, the arrangement of the contents of the syllabus concurs with Brown's (1977) definition of a typical (Integrated) Science curriculum:

... it (Integrated Science) may be perceived as a curriculum centred around the interests of pupils, for which subject boundaries are not pertinent; or it may be a course framed by certain topics, themes, or problems that require a multi-disciplinary approach (p. 32).

It appears that the science curriculum was developed with the above concern in mind. However, the fact that the development of this work rests only on a Teachers' Guide implies a restricted scope and view of the curriculum. This, therefore, precludes any discussion concerning the extent to which the above-mentioned balance of learning science concepts and applications is maintained across different media and resources provided for teaching.

Thirdly, this time the curriculum is not a package. Schools have only been given the science syllabus document. There were no Teacher Guides issued and no new textbooks for pupils. In the past, only one comprehensive text published by the Ministry of Education was the standard text throughout Botswana and this formed part of the curriculum package dispatched to schools. As with its predecessors the curriculum was not trial-tested before implementation. Its implementation date and that of the entire school curriculum were decided by politicians. It is against the above background on education policy formulation and curriculum development that the rationale for the study and research questions are developed and presented below. The background demonstrates a clear need for research focused on curriculum implementation.

1.4.0 Rationale for the Study

There are four key reasons for undertaking the study. First, as explained, education in Botswana is influenced by political and socio-economic forces seeking to foster close links between national development and education. For this reason, educational changes do not derive their *raison d'être*

from educational theories, paradigms, or research, so curriculum development is not shaped by what happens in the classroom but by what politicians feel should be the ideal. This makes investigating implementation of curriculum influenced by such a model important.

Secondly, the scale of the educational enterprise, the financial and political will and commitment in Botswana justify the study. Education currently receives the third largest share of the national budget. The building of schools, teacher training institutions and the widened access to basic education are all clear examples of the commitment. However, it is imperative for purposes of understanding how policy is implemented in practice to know what happens in classroom life and how teachers explain the situation.

Thirdly, as suggested in Appendix 1, the implementation of the previous science curriculum seemed to have attracted little research interest from either educators and policy-makers, so there is a paucity of research in this area. Such a situation means no or poor feedback mechanisms within the educational sector and implies that relatively little is known about the education system itself. This study is an attempt to fill the gap.

Finally, the research undertaken is for both personal and professional advancement. Being a teacher educator myself, a reasonably firm understanding of teaching in schools is vital for various reasons, particularly for pre-service teacher education courses. Also, a long-term engagement in understanding issues on science teaching is envisaged mainly for developing and promoting wider interest in the area.

1.5.0 Purpose of the Study and the Research Questions

The purpose of the study is to systematically explore, describe and interpret how the new science curriculum is implemented in classrooms in CJSS in Botswana. In order to carry out an in-depth study of the problem, the following research question was developed. The main question is:

How do teachers in Community Junior Secondary Schools implement the integrated science curriculum?

To answer this question, the following three subsidiary research questions were posed:

- a) **What activities are observed in the classrooms during the use of the curriculum?;**
- b) **What explanations of activities do teachers give?; and**
- c) **What explanations can be developed from the field data?**

The study also sought to consider conclusions derived from the research data. This led to the following question being posed:

What conclusions can be drawn from the study?

The research questions highlight the exploratory, interpretive and the observation-based nature of the study. The research led to a total of 12 chapters being developed in the work. A brief overview of the chapters is explained below.

1.6.0 Structure of the Work

This chapter presents an overview of the science curriculum whose implementation is the focus of the study. It also sets a context and a preliminary overview for understanding the purpose and scope of the work. In the second chapter, "Locating and Contextualising the Study", David Hamilton's study of integrated science teaching in Scotland and Bob Prophet and Pat Rowell's pioneering work in the study of science education in Botswana are discussed. The discussion focuses on research findings and methodological issues as a way of placing this study within the field of studies on curriculum change. Most importantly, their research-based work was on the implementation of a curriculum, which shares many attributes with that studied in this work. Also, the two studies were conducted within the first three years after the respective curricula was introduced to schools. This formed the key criteria of deciding which studies to discuss. In short, Chapter 2 looks at what is known about curriculum implementation during its establishment phase.

Chapter 3, "Methodology", provides an overview of the case study approach adopted in this study. It gives the time-frame of the study and locates the various key activities within the research process. Access negotiation and research ethics are discussed particularly because the two areas help contextualise the data collection procedures and hence the research findings themselves. Chapter 4 describes the procedures followed in data analysis. This is important for the structure of the thesis particularly that the organisation of chapters on research findings and data interpretation is based on the categories that emerged during the data analysis. The analysis led to the development of Chapters 5-8 which contain the research findings.

Chapters 5 and 6 entitled, respectively, "General Pedagogic Aspects" and "Concept Development" present a description of transactions which were observed in science classrooms. The chapters capture the learning environments as seen from the researcher's "detached" position in the classrooms. The data in the two chapters answer the subsidiary question: "What activities are observed in the classrooms during the use of the curriculum?"

Chapters 7 and 8 present teachers' perspectives of their classroom practice and the context in which they operate. Drawing mainly from interview and conversational data, they answer the question: "What explanations of the activities do teachers give?" Chapter 7, "Teachers Perspectives on the Curriculum", is based mainly on the insiders' view of classroom transactions. Here the various socio-political factors inherent to realities of curriculum implementation are exposed. Chapter 8, "Institutional Factors in the Implementation Process", is a continuation of the socio-political factors impinging on the implementation of the curriculum. Specifically, the chapter highlights how the organisation of schools and support from the Ministry of Education affect the implementation of the curriculum. In essence, Chapters 7 and 8 are not about constraints of implementation but, more positively, reveal what teachers value in their use of the curriculum.

Chapter 9 provides a short background information on my understanding of "interpretation" as it is applied to this work. The chapter is a prelude to Chapters 10 and 11. Chapter 10 deals with "curriculum in the classroom" or, simply, aspects of the teaching environment. By contrast, Chapter 11 is on management of change within the wider organisational environment. Both chapters follow from the broad categories arrived at through data analysis. The two chapters place the research findings of the study into a wider context of the literature on educational change. Here a dialogue about what the data signify is used for understanding some key aspects of the curriculum implementation. This a delicate and complex process, for a proper balance of arguments has to be developed and maintained in order to focus mainly on the curriculum itself.

The conclusions of the work are presented in Chapter 12. Hamilton's and Prophet and Rowell's work are used comparatively to highlight advances made in this study in understanding science education in Botswana. However, the research findings and associated conclusions are subject to the strengths and weaknesses of the research methodology. These are discussed briefly. However, Appendix 12, "Review of Methodology" goes beyond sharing research experiences but reviews in a reflective manner the strengths and weaknesses of the research. This enables the audience to read, understand and evaluate this work in light of the critique. It is a way of contextualising the research outcomes.

1.7.0 Summary

In this chapter, attempts are made to provide a background to the study. In particular, the purpose, intention and scope for focus of the study are presented. The rationale for the study is generally based on the need to inform stakeholders in policy formulation, policy implementation and teacher educators of the realities and intricacies of curriculum implementation. The study is primarily exploratory. This can be justified variously including, among other factors, that the study was done early in the life of the curriculum. A review of the science curriculum is also undertaken.

To recapitulate the key aspects of the science curriculum, it can be argued that the sociological foundations of the course strongly uphold the view that science pervades the intellectual, moral and material worlds of contemporary society. On the other hand, it appears a hands-on experiential approach and a constructive-interactive mode of teaching of science form the pedagogical foundations of the curriculum. The epistemological foundations of the curriculum itself are two-fold. One broad dimension is that which is both socially and academically oriented emphasising a scientific method or scientific approach in learning concepts and investigating phenomena and in teaching science as a 'unified' discipline comprising physics, chemistry, and biology is the second dimension. The foregoing covers the substantive areas inherent to the nature of the curriculum and presents a backdrop which permits developments of some expectations regarding the actual teaching of the syllabus in schools in Botswana.

The next chapter focuses on locating and contextualising the study within two studies on curriculum implementation.

CHAPTER 2

LOCATING AND CONTEXTUALISING THE STUDY

The purpose of this chapter is to describe and discuss some previous studies on implementation of science curriculum. This is intended to locate the study within the field of previous and similar studies, namely, empirical studies on policy implementation of integrated science programmes. The focus is on highlighting and critiquing research strategies used and on the research findings reported in the literature. This helps to inform the research methodology of this study.

Apart from being empirical, the studies with which this chapter is concerned should have been conducted, as was this study, during the "establishment phase" of the curriculum in schools. This is the phase when teachers try to implement the curriculum, or parts of it, for the first time. The exploratory initial encounters could be such that rules, norms and procedure are likely to be more explicit than in routine encounters and are likely to be highly accessible to researchers (cf. Delamont and Galton, 1986). Two studies on integrated science teaching which fit the criteria are David Hamilton's classic case study on the implementation of the Scottish Integrated Science scheme done in early 1970's in Scotland, and Prophet and Rowell's 1987-1988 study of implementation of integrated science curriculum in Botswana.

There are numerous other reasons for considering the two studies. As the history of science education in Botswana shows (see Appendix 1), the Scottish Integrated Science curriculum was modified for use in Botswana during the early 1970's to December 1985. As Nganunu's (1988) account explained, the curriculum used in the period from January 1986 to December 1995, whose implementation was studied by Prophet and Rowell, was a modified version and second descendant of the Scottish Integrated Science scheme. Also, although Hamilton and Prophet and Rowell's studies are in different contexts, they were both concerned with policy implementation using qualitative observational research strategies. A similar strategy is to be adopted in this work. The two studies also pre-date this work. As Merriam (1988) states, "an investigator who ignores prior research and theory chances pursuing a trivial problem, duplicating a study already done, or repeating others' mistakes" (p. 61). In general, this study continues an existing tradition of studies on implementation of science curriculum. The similarities and differences between the two studies, which further justify the reasons they are considered here, will be revealed in the course of the discussion. The studies are considered separately. The chapter ends with an attempt to position this work relative to the two studies. Hamilton's study is considered first.

2.1.0 Review of Hamilton's Study.

Hamilton's study was done in two comprehensive schools, "Simpson" and "Maxwell" Schools in Scotland, in 1970-1971. It involved four-week periods of participant observation (Hamilton, 1973) and has been widely published. See, for instance, Reid and Walker (1975); Hamilton (1975) and Horton and Raggatt (1982). Hamilton's concerns were two-fold. He was interested in "describing and interpreting certain phenomena associated with the introduction of integrated curricula" (Hamilton, 1973, p. 146). Secondly, he wanted to use the data to develop some features of the model of integrated curriculum types which were proposed by Basil Bernstein. The Scottish Integrated Science Scheme was used as an exemplar.

Hamilton details the history of the scheme which he traces from 1964 when a working party was set-up to develop a science programme for "non-academic" pupils to the publication of the full details of the scheme in 1969. The scheme was highly regarded for its unification of physics, chemistry and biology, ideally to be taught by one teacher, and for its suitability to both streamed and unstreamed classes (Hamilton, 1973; 1975). The scheme was introduced into schools as a package comprising outline syllabus and worksheets for the entire course; the worksheets were not to be used as texts but as "props to support discovery methods" (ibid.). The course was also intended to cover the first two years of secondary education (ages 12 +) and almost "90 per cent of Scottish Secondary Schools reported they would be following the scheme during the year 1971-2" (Hamilton, 1975, p. 181). The Maxwell and Simpson Schools were different in various ways and separate reviews of Hamilton's work in the two areas is done below.

2.1.1 Simpson School.

At Simpson School, Hamilton worked at an annexe offering only first year subjects to thirty mixed ability groups. The study was conducted on a new curriculum hitherto non-existent and fitted into an existing organisational structure. Teaching in the school was subject-specific with separate departments for physics, chemistry, and biology. The integrated science curricula was "grafted on to the pre-existing organisation" (Hamilton, 1973, 1975). As Hamilton notes, there was a problem of teachers who, as university graduates trained to teach specified subjects, had a "strong subject loyalty induced and strong compartmentalisation of established subjects" (p. 179). Subsequently, individual teachers in teaching the integrated science course either had to concentrate on areas related to their specific subject disciplines or, carried on teaching where the previous teacher had left off.

The above concerns only the furthest point Hamilton reaches regarding teaching. The processes of teaching and the interpretation of the curriculum itself by teachers have not been discussed. Nonetheless, he notes that "worksheets had become the syllabus rather than support materials, and, as teacher demonstrations were often substituted for practical work, class teaching had

become dominant activity" (Hamilton, 1973, p. 149). However, this is still insufficient to offer insights into the implementation of the curriculum; in particular, as to why the teaching was such that the worksheets had become the syllabus. In other words, while teachers were loyal to their respective subject disciplines, that does not explain their actions, though it suggests a probable cause. In terms of methodology, the teacher's voice is missing, and the report of the findings tends to be researcher-centred (i.e., detailing what the researcher saw and his perceptions of the situation).

The physical environment at Simpson School is portrayed by Hamilton as unresponsive to the new curriculum. Lack of proper laboratory accommodation and shortage of science equipment were the main problems. Also, according to Hamilton, the large number of teachers (a total of ten) and the multiple teaching of classes were the basic constraints on science teaching. Teacher absences and the fact that the integrated science was being implemented for the first time at the school exacerbated the problems. What Hamilton does not say is how the situation impacted on the curriculum itself or on its philosophy. Also, the account of what happened at Simpson School does not give a balanced picture of the positive and the negative aspects of the environment, but gives a unidimensional view which fails to give insights and in-depth understanding of how the curriculum was remodelled on site by various other ecological constraints apart from the organisational framework.

2.1.2 Maxwell School

The situation at Maxwell School was different. The school was new and had sixteen laboratories; half of which were architecturally subject specific (Hamilton, 1975). There were sixteen mixed ability groups in each year around which the integrated science teaching was organised (ibid., p. 189). On the other hand, all the science teachers were new to the school, had never worked together, and were selected with the help of the local science adviser (ibid.). The adviser had been involved in developing some aspects of the integrated science curriculum and "had recommended teachers who would be keen to develop integrated science" (ibid.). Unlike at the Simpson School, the curriculum was introduced into a new environment and it exerted a deterministic influence on the organisation of the science department and on teaching. The environment was thus accommodating, enabling and organisationally responsive to the demands of the new curriculum. As Hamilton incisively notes, teachers worked in a "show" school (1975, p. 189) and were psychologically and organisationally committed to seeing to the meaningful implementation of the curriculum.

This resulted in teamwork and strong collegiality between teachers such that the difficulties experienced with the curriculum resulted in the establishment of a versatile, resilient and "sophisticated organisational structure" (Hamilton, 1975, p. 189). Furthermore, it can safely be said, given the picture at Maxwell, that the philosophy of the curriculum stood a reasonable

chance of being preserved and of influencing classroom dynamics. However, Hamilton did not focus on the issue, and classroom transactions are not reported, although the study was observation-based. Instead, Hamilton was concerned with the impact of organisation of staff, collegiality in particular, on teaching.

Nonetheless, the aims of the course caused problems to teachers, although the department as a whole sought "agreed common ground rather than allowing divergence of content and method" (Hamilton, 1975, p. 191) for individual teachers. This is one example of how teacher identity and professional autonomy were compromised. As one teacher reportedly said, ".. we're so organised, at times I don't know what I'm doing" (ibid., p. 190). Such a position is suspect if, as we are led to believe, the teachers were chosen for their keenness to develop the teaching of the curriculum rather than for being 'powerless functionaries' in the process. Another example in which collegiality encroached into the teachers' professional autonomy is the 'lock-stepped' teaching across a particular year whereby common "dates were fixed well in advance for the completion of the various sections and for the setting on the multiple choice section tests" (ibid., p. 190). The impact of the arrangement on the quality of teaching and on the curriculum itself was left unexplored and unexplained: the interplay between the data and the curriculum is weak.

What is clear is that Hamilton was concerned with management issues and organisational structures for implementing the integrated science curriculum. Reid and Walker's (1975) introduction of Hamilton's paper "Handling innovation in the classroom: Two Scottish Examples" makes explicit Hamilton's findings that: "conflicts may arise between the organisational style of the school - student grouping, departmental structures, decision-making machinery - and the demands of the new curricula" (p. 179). The situation at Simpson School is clearly in line with the conclusion that "the introduction of integrated studies is not merely equivalent to introducing a new syllabus but implies a radical change of emphasis in the organisational context and thinking of secondary education" (Hamilton, 1973, p. 154).

In terms of methodology, Hamilton's study can be characterised as a comparative case study. Although the conditions in each school are detailed, it could be argued that the two fundamentally different schools naturally introduced and encouraged different practices. In other words, it can be said that it is little surprising that the subject-specific teachers and departments at the Simpson School rejected the curriculum that was being designed for them. On the other hand, where teachers had been appointed on the basis of interest in integrated science, the optimism and expectation that they will be committed to fitting the image is not surprising. The two environments were disparate in most respects, and not typical or representative of the wider environments in which the curriculum was adopted. Also, there exists a "grey area" in between the research findings of data from the disparate environments. Hamilton does not fill the gap by promoting a dialogue between the two cases. Furthermore, the potential for promoting

understanding of implementation of the curriculum in the establishment phase through case study strategy has not been fully explored through failure to locate the study within the classroom environment itself.

However, other researchers conducted studies later which addressed areas untouched by Hamilton's work. One such study was undertaken in 1976 by Brown and McIntyre together with Drever and Davies. The comprehensive study on the implementation of Scottish Integrated Science scheme involved 50 comprehensive schools (Brown and McIntyre, 1978). In a paper by Brown and McIntyre, the barriers to effective implementation of the curriculum are listed as: "the meaning of the innovation; its perceived value, whether it is 'organisational' or 'pedagogical', the procedural clarity of its presentation and departmental pressures" (p. 19). In covering these areas, the study fulfilled two purposes. Firstly, it compensated for deficiencies noted in Hamilton's study particularly relating to how the environment impacts on the innovation itself. Secondly, while Hamilton's framework of analysis was Basil Bernstein's position on curriculum implementation, Brown and McIntyre's work was located in the wider general field of the time which had interest in wider factors important in curriculum implementation.

For instance, the factors were the subject matter of authoritative articles by OECD (1973), Havelock and Huberman (1977); Huberman (1979); Hoyle (1975); and Bolam (1975). What is important in Brown and McIntyre's study, and in relation to Hamilton's study is that teachers at Maxwell School claimed that they were so organised as to lose professional autonomy in classrooms. Brown and McIntyre's study revealed a different picture. In discussing the notion of "pedagogical innovation" which "imply that teachers are being asked to change behaviour, lesson content or organisation that goes on in the privacy of their own classroom", they note that "the decision to implement or not belongs to the individual teacher". Their conclusion is that their studies of "pedagogical innovations have produced very little evidence of effective implementation" (p. 21). This challenges the validity of Hamilton's findings at Maxwell School. But as Hamilton has indicated, teachers were conscious of the fact that theirs was a "show" school which influenced how they acted out their positions.

However, just as in Hamilton's case, Brown and McIntyre found that the meaning of integration related to organisational features of teaching but did not "imply anything about the method or substance of the knowledge imparted" (p. 19). But as other science educators of the era showed, the meaning of integrated science or integration remained illusive, both at the theoretical and at the practical level. Incisive arguments on the issue are raised by, for instance, Dale (1973); Pring (1971); Thier (1973), Brown (1977) and later Wellington (1982); Arca and Vicentini-Missoni (1981) and Hodson (1985). The arguments will not be repeated here.

In summary, Hamilton's study has shed some light on how organisational factors impinge on the adoption and use of curriculum materials. The pioneering study is also important as it looks at implementation of curriculum in contexts (i.e., Scottish Schools) it was designed for. This is one of the main similarities between Hamilton's and Prophet and Rowell's study in Botswana which is discussed next.

2.2.0 Overview of Prophet and Rowell's Study

Prophet and Rowell undertook fieldwork on curriculum implementation in five CJSS in Botswana over a sixteen-month period between February 1987 and May 1988. According to Prophet and Rowell (1988), classroom observations and informal discussions were the main modes of data collection. "The focus for the study has been a portrayal of the activities which constitute the daily realities of teachers and students in classrooms" (p. 2), states Prophet and Rowell. Furthermore, "such a portrayal has the potential to reveal the curriculum-in-action in contrast to the curriculum-as-planned, either by developers or teachers" (p. 2).

The qualitative observational study thus focused on classroom transactions during teaching. However, the study was not exclusively focused on science teaching. According to the report on the study, the researchers considered the whole spectrum of subjects in the then 9-year basic education curriculum (ibid., p. 3) introduced into schools in January 1986 and used until December 1995. The curriculum comprised the six core subjects (English, Setswana, Mathematics, Science, Agriculture and Social Studies) and selected optional subjects (Art, Home Economics, Religious Education and Technical Studies) (ibid., p. 1).

The integrated science curriculum was "essentially aimed at providing pupils with knowledge, skills and attitudes needed for understanding and responsible participation in our society" (Ministry of Education, 1986, p. 1). Also, being based on mixed-ability teaching, extra activities were provided in pupils worksheets and teachers guides to cater for 'faster students' (ibid.). Furthermore, it is stated that the syllabus was intended to be pupil-centred, based on discovery methods of learning, and covered some themes and topics some of which are of immediate practical application. The rhetoric creates expectations of the key areas to be covered in the study such as Prophet and Rowell's in which the curriculum-as-implemented is checked against that planned.

The significance of Prophet and Rowell's work to science education in Botswana is based on two key points. Firstly, it was probably the only study into the first curriculum changes signifying major educational reforms in Botswana following the recommendations of the first National Commission on Education of 1976. The broad principles and philosophy developed by the Commission were used as the basis for developing the new curriculum which is the subject of this study. Secondly, the work has been published in international journals and has enjoyed wide

readership and popularity as evidenced by widespread reference to it in a substantial number of journal articles. Thus, the study is also considered here because of its influence in and significance to understanding science education in Botswana: it is thus a logical starting point for any science policy implementation research in Botswana. The original report of the research findings made to the sponsors of the study, the Ministry of Education USAID/JSEIP, and the subsequent journal publications of the study provide the information considered here. However, much of the information comes from the report which is an uncorrupted source of evidence. Journal articles themselves were less explicit on methodological issues.

In reading the review, two things will be apparent. One is that the section is long and detailed compared with Hamilton's where I relied only on journal articles which are by their nature short and restricting. Secondly, because Prophet and Rowell, unlike Hamilton, spelled out in detail the classroom realities, the review has consequently become long. The differences in treatment should thus not be taken to be a bias towards one or the other study.

2.2.1 Review of the report

In the review, quotations are used quite extensively and liberally. This is done because the report itself is not widely available either in Botswana or internationally. The report is written in a typical qualitative style of interspersing and alternating points with illustrative evidence and descriptive interpretations. Also, considerable effort was placed by Prophet and Rowell into capturing the verbal teacher-pupil interactions or exchanges in classrooms. None of these intricate details will be rehearsed in this work which is in three sections. They are: the focus for the study, methodological concerns and the main research findings. The three areas are interrelated and the interplay between them will be demonstrated by the discussions.

2.2.1.1 The focus for the study

Contrary to the statement that the study sought to capture and portray 'daily realities of teachers and students in classrooms', the individual interests of the researchers ultimately *defined* the new foci for the study. Prophet and Rowell state that:

This study is the result of the work of two researchers who shared a common view about the essence of the problem being considered and the research approach to be used. As the study progressed, each assumed a different perspective from which to examine the information being collected. ... One of the researchers became interested in the concept of 'practical' which was being applied to a very specific group of subjects within the curriculum and the other in issues concerning language and skills development within Integrated Science curriculum. The final report reflects this divergence (p. 3).

This is a marked deviation from the initial intent of the study which is rather a consequence of the researcher-imposed frameworks of data interpretation.

As stated in the citation, the researchers had different interests and the report is in two sections. One is authored by Prophet and the other by Rowell. Although Prophet gives a detailed description of transactions in science classes, followed by a detailed focus on 'recurrent happenings' viz., "ignoring pupil answers, random pupil responses, use of elite language and sentence completion" (p. 24), the vacuum created by the two researchers through selectively focusing on their nominated areas of interest is reflected in the lack of depth, breadth and scope of the data on science teaching. For instance, there is no data on out-of-school experiences in the classroom. Nor is there evidence or discussion on the use of low-cost materials in science teaching. From a curriculum planner's position, the two areas formed the core of the curriculum. They were also significant as this was the first major attempt in science education in which the curriculum overtly sought to create links between science and the pupils' environment.

Rowell's report on classroom observations, focusing on "question and answer exchange, written exercises, notes and tests", displays the problems of dealing with *all* subjects in the curriculum. Rowell's report draws observations from lessons on Agriculture, Social Studies and Home Economics though it is weakly developed. The section is primarily used by Rowell to illustrate the uniformity of the daily routines and interactions in the CJSS classrooms. Data drawn from other areas of the curriculum (Art, Religious Education, Setswana, English and Mathematics) is conspicuously absent in the 102-page double-spaced report. Rowell's description of science practicals is also relatively very weak. It thus failed to give practicals a distinct place in science teaching or to match their prominence in rhetoric of the curriculum and the emphasis that was placed on discovery-based learning. More seriously, and perhaps highlighting the main flaw caused by different concentration areas of the duo, Rowell's account fell far too short of complementing Prophet's. There is thus a clear gap in data on science teaching.

The picture painted above demonstrates three points regarding the research. One, the two researchers concentrated mainly on science-related subjects. This is contrary to the claim that *all* subjects in the CJSS curriculum were considered. Also, observations from mathematics and English classes are weakly presented. Second, it shows the researchers' lack of expertise to cover the entire curriculum. They were both expatriate science educators at the University of Botswana and looked unlikely to have taught in schools in Botswana which would have helped them to fit into the research environment. Thirdly, Prophet and Rowell were likely to have been overcome by the sheer scale and demands of covering *all* the subject disciplines through qualitative classroom observations. This compromised the quality of the study in a number of ways, amongst them issues on research methodology. This is discussed in the next section.

2.2.1.2 Issues in research methodology

The research methodology issues noted in the report are explored by focusing on two areas. One is the *declarative* statements on research methodology made in the report. The other area is procedural matters pertaining to the actual and reported conduct of the study. The declarative statements on methodology made by the researchers provide insight into methodological convictions which inform the researchers' conduct at a more generalised level. While, on the other hand, the actual conduct and procedures followed in fieldwork are taken to be the researchers' operationalisation of the convictions on methodology. The two areas are considered separately.

2.2.1.2.1 Declarative statements on methodology

Three key statements have been identified and regarded as crucial for purposes of understanding the methodology adopted in the study. The statements are critiqued here and attempts are made to reconcile them with the general strengths and weaknesses of the report. The first statement states that:

This research took the form of classroom observations and informal discussions in five junior secondary schools in Botswana (Prophet and Rowell, 1988, p. 2).

As has been stated elsewhere in this chapter, the study was conducted over a sixteen-month period and covered the entire school curriculum. In this context it might seem that informal discussions with teachers were on their own probably inadequate to solicit comprehensive data on science curriculum implementation. The point being raised here is that perhaps the informal discussions should have been supplemented with formal interviewing. The report also makes no reference to interviews with teachers. The use of formal interviews might have diluted the ethnographic tradition of relying on informal discussions but the change would possibly have been justified by the circumstances Prophet and Rowell operated in.

However, and rather surprisingly, the report contains only two instances in which teachers' views from the informal discussions were expressed. The statements, made in Prophet's section on classroom observations are used to show teachers' concern with pupils passing examinations. The teachers' views were not explored further nor was their significance to the study and teaching discussed. No other informal discussions with teachers are cited or acknowledged in the report. This suggests that the study was perhaps predominantly observational. The impact on data outcomes of lack of interviews and the rather restricted informal discussions are discussed later in the section on the review of the main research findings.

The second declarative statement concerns the research sample. The statement states that:

Two urban schools were visited regularly (once or twice a week throughout a sixteen month period between February 1987 and May 1988). An entire week of the second term was spent in a rural school in 1987 and again in 1988. Two remote schools were visited for a week in the second term of 1988. Taken together, these visits represents many hours spent in the classroom of junior secondary schools (p. 2).

On a point of clarification, the school calendar of primary and secondary schools in Botswana, starting in January to December of any given year, comprise three 14-16 week terms (semesters). It is not clear from the report as to why the five schools in different settings were chosen and the position school that each had in the study. The regular visits to the two urban suggest that they were used as the main sources of data. As Prophet (1995, p. 128) explains, "they were chosen for their relative proximity to the University which allowed access at convenient times for the researchers". With the wide socio-economic disparities between urban, rural and remote settlements (see discussion in Chapter 3), the findings in the report do not make reference to the three settings and data collected in them. This does not reflect well on the prominence that the schools were given in the above citation. Furthermore, it does not reflect on aspects of triangulation which is the cornerstone of findings and studies framed in the qualitative research tradition. This observation should be seen in light of the third declarative statement explicitly explaining the methodological conviction Prophet brought into the study.

Following his observation that "it is difficult to discern and describe the pedagogical principles behind teachers' actions" and that "it is tempting to say there is no deeper meaning to the interactions taking place", Prophet wrote:

However, the ethnographic research technique selected to illuminate perceptions of classroom life operates at two levels. The first provides an in-depth description of a situation accepting that the ethnographer in writing the description is involved in translating observed and sometimes chaotic and meaningless events into some sort of order. The second level requires a more analytical look at the description to search for relationships and meanings in an attempt to construct a theoretical model for that described reality (p. 24).

The fact that the observer gives a personal view of events observed cannot be argued with. What the citation shows is that checking the researchers' interpretation against those held by participants was not undertaken in the study. Lofland and Lofland (1984) (see also Olson and Reid, 1982; Brown and McIntyre, 1993) explains problems associated with this mode of operation:

... researchers who do not comprehend participants' own causal theories are apt to make profound errors not only in ascribing causes but also in characterisation ... This is especially likely where there is great social distance .. between the analyst and the participant (p. 103).

The above-mentioned pitfall is reflected in Prophet and Rowell's report by the conspicuous dearth of reference to interviews and teachers view points. It will be seen in the discussion of the findings how the pitfall was manifest in the study.

In summary, the researchers' three declarative statements discussed above provide insights into processes in data collection but do not reveal the actual operational details in the field. The next section focuses critically on the issues arising out of the procedures in data collection. The debates revolve around a number of caveats in research methodology which help to inform the research strategy for my study. Also, the caveats have the potential to shed more insights on Prophet and Rowell's study and its outcomes.

2.2.1.2.2 Caveats in research methodology

The preceding sections have shown how there had been a change in the initial focus of the study leading to a series of inadequacies in the study. This section considers some of the main caveats in the research methodology. The caveats are in two subsections: researcher's assumptions and experiment-based investigations.

The main flaw noted and that which affected the entire study is that the researchers seemed to have assumed that understanding policy implementation can be based almost exclusively on verbal teacher-pupil interactions. The consequence of this, as the report of the study shows, is that the science curriculum was not the major focus *per se* in that the investigation of curriculum use is implied but is not made explicit in class transactions. In fact, no reference is made in the report to the official curriculum as a major factor in guiding classroom transactions: it is not apparent what occurred in class as a consequence of the curriculum. In other words, the report's interpenetration of the data and the ideal curriculum is relatively weak and obscure. The influence on teaching, if there were any, of the teachers' guides supplied with the curriculum package is not commented on. What is apparent, though, is that examples used in the report are of some topics drawn from the curriculum but the "segregation error" (Lofland and Lofland, 1984) of the data and the curriculum is glaring. The main root cause of this problem is the different researcher-imposed concentration areas in data collection. They demonstrated a shift in research strategies from a qualitative approach to some form of quasi-experimental approaches. The next section analyses the shift in the methodological position focusing particularly on the caveats it introduced into the study.

Two experiments were undertaken in the study. One study, based on constructivist perspective on learning, investigated the nature of the conceptions of three labels, namely, Plant, Animal and Food held by Botswana Junior secondary school students (Prophet and Rowell, 1988, p. 56). The intent of the mini-study was to "provide a description of the concepts developed by students from

three labels which feature predominantly in diverse fields of study" (ibid.). The justification for the mini-study is given thus:

The study grew out of many hours of classroom investigations in which students appeared to rely heavily on teacher definitions, and in which there was a singular lack of oral exchanges between students and teacher which could contribute to the construction of understandings (ibid.).

Nonetheless, there seems to have been confusion over the purpose and intent of the exercise. While it was claimed that the experiment followed from classroom observations, another statement gives a different purpose. The statement reads that the experiment "was not intended to provide any correlations between students in specific locations, but rather to assess the feasibility of pursuing investigations into student thinking patterns in science" (p. 58). Suffice it here to say that the change in focus is rather puzzling as is the fact that the experiment was conducted outside the normal teaching context. In the mini-study conducted outside regular science teaching period and during afternoon study (i.e., student preparation times), "students were asked to respond to open-ended questions which encouraged expression of individual ideas rather than the provision of textbooks answers" (p. 57).

The second experimental study investigated the development of manipulative skills in "Batswana junior secondary students". The prelude to the study presents some of the realities observed in practical work but falls rather short of completing the picture on the use of the science curriculum in classes observed. Justification for the investigation is expressed thus:

In an attempt to assess whether these perceptions [i.e., the researcher's] of the pupils' lack of development in manipulative skills had any basis, a small scale study on estimating and measuring skills was carried out. The intent of this study was to provide a description of the level of these manipulative skills developed by the pupils during their two years in the junior secondary schools (p. 79).

Clearly the researcher had doubts about his perceptions and observational data. I believe that explanations for lack of development of skills and the form in which such underdevelopment was manifest were supposed to emerge from interviews and discussions with teachers. As Woods' (1979) states, "the 'meaning' attributed to an action or utterance can vary according to actors' or speakers' definition of the situation. If we do not know the latter, we cannot assume the former" (p. 13). The lack of participants' views is one of the main flaws in the study.

The situation above shows that the researcher abandoned the commitment to qualitative research strategies and, instead, placed faith in positivist strategies which promised potential and efficiency in yielding decisive conclusions. My earlier remark in this chapter that triangulation was weakly used for validating data and conclusions has now been indirectly confirmed by the shift in research strategy. In the process, qualitative research strategies were undermined. Also,

according to Guba and Lincoln (1988) and Crossley and Vulliamy (1997) mixing qualitative and quantitative research strategies in any one study implies a conflict between two fundamentally and diametrically opposed research traditions, positivist and non-positivist. This leaves open to question whether the study was appropriately characterised as "ethnographic". The experiments also suggest another weakness in research methodology. While giving 'spot-on' findings, mounting experiments showed that the studies not only occurred outside the normal context in which they would normally be manifest, but also that the two areas were not studied systematically over time (as in the case of longitudinal studies) during the sixteen-month period of research.

For this reason, the validity of the findings is compromised in at least two ways. Firstly, it creates an impression that the research on its own lacked clarity and precision of focus. This is a methodological problem which should not have arisen with proper procedural strategies such as "progressive focusing" or with use of other grounded theory procedures. Secondly, the experiments continued to promote the failure in the study to create the interplay between the curriculum and the classroom process. Instead, preoccupation devolved upon the outcomes of experimentation. I believe that these major flaws in the study are adequate for this review. The next section presents the major findings of the study.

2.2.2 Research findings

The findings are drawn from the report of the study. Once more, direct quotations are drawn liberally from the report used. A look at the interpretation of the findings is undertaken as this provides more insights into the study itself, particularly with regard to the methodological issues raised earlier. The findings and interpretations are considered separately.

2.2.2.1 Classroom observations

The findings are drawn from Prophets' account of experiences in science classrooms. It should be remembered that Rowell, the other researcher, focused on the 'practical' dimension of certain curriculum subjects, including science.

Prophet noted of the "large amount of teacher talk which involves mainly teacher lecturing at the pupils interspersed with questions, generally asked to the whole class with predetermined expectation of answers" (p. 14). He also noticed "the amount of time spent by pupils silently working on teacher assigned tasks. These tasks are generally "'whole class' assignments at which the pupils are expected to work independently at the same rate" (p. 14). He noted that this routine was universal in the classes observed, "irrespective of the subject under consideration or whether pupils are Form one or two" (ibid.). On the other hand, asserts Prophet, "the pupils themselves rarely speak except when spoken to. Throughout all the hours of observation notes very few pupil questions can be found and most of these were concerned with procedural problems such as 'shall

we copy that" (p. 21). This portrait of the classroom is not encouraging. The respective images of and roles played by teachers and pupils suggest that the classroom environment was far from student-centred as advocated in the syllabus document.

In giving a refined picture of classroom realities, Prophet concentrated on four "recurrent happenings" or "significant moments". The four, "taken to characterise social patterning of interactions taking place in the classroom" (p. 24), are: "ignoring pupils answers, random pupil responses, use of 'elite' language and sentence completion" (ibid.). For some reason, the four areas were not treated in any great detail. In all cases, a short statement is made followed by an illustration, then a short interpretation. The four statements are worth repeating here particularly for purposes of critiquing them. The first statement relates to *ignoring pupils' answers*:

Extended question and answer sessions are a common feature at the start of the lessons and also at the end of long sessions of teacher talk. In both cases it seems to be viewed by the teacher as both a revision exercise and evaluation of teaching. Within these sessions it is a common practice for teacher to completely ignore many pupil responses and only acknowledge certain 'correct answers' (p. 24).

On *random responses*, it is stated:

Possibly in response to the arbitrary rejection of pupils responses by the teacher, the pupils in turn appear to answer teacher questions in a random manner. "Guesses" are the accepted order of things and it seems more important for the pupil to participate by saying something, however wrong, rather than not respond (p. 26).

On the other hand, the use in teaching of *elite language* is introduced thus:

In the more technical subjects, especially science, there is a massive emphasis on the correct use of scientific terminology, more often than not at the expense of understanding (p. 27).

Prophet's fourth area of concentration was *sentence completion* noted in teaching. He asserts that:

By far the most commonly used question and answer technique for all subjects involves the pupils completing, often in chorus, the teacher sentences. The completed sentence or missing word is then repeated by the teacher (p. 29).

The four statements clearly show the researcher's concern with teacher-pupil verbal transaction as symbolic of the curriculum-in-action. Several criticisms can be made of the statements.

One criticism is that while the researcher has provided an illustration for each case, there is no evidence to show the limits of his ideas, or to contradict an idea or generalisation (cf. Riley, 1996). In other words, there is no balance in arguments, as only a perfect and fitting view of the

situation is given. Another major criticism is that the statements are mainly speculative of the various forces integral to an observed phenomenon. For instance, *the statement on ignoring pupil answers, random responses, and elite language* have parts which are speculative.

From a methodological point of view, the speculative statements demonstrate some weaknesses in the study. The weaknesses are seen here as a consequence of discontinuous and extended absence from the field caused by making only one or two weekly visits to the research sites. This naturally created knowledge gaps in the observation data such that each data for each visit existed in isolation without a clear link with the previous set. More importantly, it was easy to miss significant events which formed precedents in teaching and served as part of the negotiated working order in classrooms. Thus, what was observed in any class was preceded by certain events which cannot be recovered through observation. The observational discontinuity and informal discussions fell far too short to present a coherent and non-speculative explanation of classroom events. Also, as I see it, the main problem is lack of strategies for systematic analysis of the qualitative observational data. Clearly, Prophet's interpretation of each of the four cases cannot be more precise and reliable than the data from which they are derived. The interpretations are given below.

2.2.2.2 Interpretations of the research findings

Prophet and Rowell's interpretations of research findings are discussed here because unlike Hamilton's case in which he dealt with some theoretical model on curriculum integration, Prophet's explanations are framed in the context of language and culture. He has thus tried to place issues within wider social setting. The interpretations have also informed the world of the nature of science teaching in Botswana.

As has been said, the interpretations are speculative. The three citations below illustrate the point. Regarding the *ignoring of pupil answers* by teachers, it is stated that:

There may be a variety of reasons why teachers use this technique: they may feel that time is short and they do not wish to be side-tracked by incorrect answers or they may not have the knowledge base to deal with the suggested answers. Whatever the overt reason it is suggested that the technique is used by teachers as a control mechanism to reinforce status and authority in the classroom (p. 25).

Without knowledge of how teachers interpreted their actions, the researchers' suggestion is imposed on the situation and is thus not evidence-led. On the other hand, while Prophet found that pupils in "all classrooms observed .. have difficulty in expressing their ideas and most appear self-conscious in their use of English" (p. 30), the link between that observation and *sentence completion* was not investigated. However, the interpretation of the situation (i.e., sentence completion activity) is given thus:

Faced with large classes and a variety of stages on competence in languages, it is suggested that one of the 'coping strategies' utilised by teachers is 'sentence completion'. By simplifying and actually phrasing the idea for the pupils while still leaving them some input in the form of a missing word it seems teachers feel they are resolving the problem. The simple repetition of the word or the complete sentence is thus perceived as a reinforcement of the idea, although based on fundamentally flawed concept of learning; that the repetition of words leads to understanding of the meaning of these words (p. 30).

Once more the speculative interpretation shows knowledge gaps in research in the form of teachers' views. In the conclusion to the chapter, Prophet states that "development of concepts, attitudes and manipulative skills emphasised in the syllabus, appear not to be taking place. Further, it is suggested that these processes are actually being inhibited in the classrooms rather than being developed" (p. 31). While the assertion might be valid, Prophet explains away the situation by bringing in contextual factors which were not given any prominence in the findings. Ironically, this shows where the study has failed: to appreciate and capture reality as teachers see it and how the environment in which the curriculum is implemented is integral to the observations and explanations. He states in the conclusion that:

It is easy to lay the blame on teachers for the apparent failure to implement a very laudable set of curriculum aims but this however fails to appreciate the complexity of the situations. Faced with large classes, syllabuses overladen with content, expectations from pupils, parent, head teachers and the local communities who see JC examination success, even though unattainable by majority, as the priority of the schools, and an examination which still emphasises and rewards simple rote learning and recall skills, it is no surprise that teachers utilise a set of strategies that ensures their survival in the classroom but fails to take cognisance of individual pupils and their development (p. 31).

The conclusion gave prominence to factors which, as has already been stated, were not accounted for in the research findings. Furthermore, the explanation shows the researcher's preoccupation with examinations such that teaching activities are seen in terms of their utility for passing examinations. Actually, evidence of this preoccupation appears in the report in two separate instances. In one instance, he stated that:

It is clearly obvious from our observations that classroom activities do revolve about the transmission of information: that the teachers' main concern is to 'teach' something they consider important and the pupils to 'learn' this. For both groups of participants in the process the utility value seems to be in 'passing JC' and this concern is often expressed in classrooms (pp. 22-23).

While three teachers' perspectives are given to support the statement, there is no evidence that pupils shared this concern with passing examinations. Earlier in the report, and as a second instance, Prophet's assumption of schools as transmitters of knowledge is revealed. He stated that:

To analyse what is taking place in the classroom a perspective focused on teacher-pupil interactions will be used. This should provide indicators of expectations of the participants in terms of roles, acceptable practices and, perhaps most especially as this is what schools claim to be most concerned with, transmission of knowledge (p. 15).

Quite clearly, there were various sorts of assumptions which researchers made but which were not investigated in the course of the fieldwork. But with the speculative nature of explanations in the report, Lofland and Lofland's (1984) advice on report writing in qualitative studies is highly appropriate here. They state that:

It is perfectly appropriate to be curious about causes, as long as you recognise that whatever account or explanation you devise is conjecture. ... And, since these will merely be stated and likely left untested, it behoves you not to allow causal conjecture portions of the report to become large or dominant part of the study. ... Because you are, in fact, unlikely to have systematic knowledge of the association of variations, it is wise to present your conjectures in a way that indicates humility (pp. 102-103).

But sixteen months of hard work suggests it is not worthwhile for the researchers to show humility in the report, particularly in view of the intensity of research. The humility in this case cast doubt on the length of time taken in studying the implementation of science alone (i.e., separate from other curriculum subjects). In fact, the report does not pose any quantities regarding the number of classes observed, number of hours spent, practical sessions observed, number of teachers involved and documents collected in the field. The speculative explanations and the researchers' humility displayed are actually fatal blows to the study in two ways. First, the study's authority is discredited. Second, the restricted outcomes of the study, incommensurate with the input in terms of economies of time, money, and importance of the sponsored study, are unjustifiable.

Rowell's concentration on the meaning of *practical* across other subject disciplines, is not reviewed here as it has little to contribute to the understanding of implementation of the science curriculum. Though her section cover some aspects of practical work in science, it has already been argued that it does not significantly complement Prophets' work on curriculum implementation. Prophet's experiments are not covered simply because they are a diversion from the qualitative and 'ethnographic' nature of the study. Nor do they illuminate further the reality of classroom teaching.

Hopefully, the extensive citations used in the review have served to preserve the integrity of the issues raised in the report as it is the original and uncorrupted source of information. Further, the key principles of the curriculum-as-planned have not received much attention in the study. However, the researchers covered the roles in class played by teachers and pupils, suggesting the researchers' concern with the extent to which teaching was pupil-centred. Mixed ability teaching, use of low cost material and teaching the dual curriculum preparing some students for life as

school drop-outs and others for further studies, for example, have not been covered in the study. In other words, the significance of curriculum change in terms of it being the Botswana's first ever 'home-grown' product after decades of using adapted curriculum has been lost in the study through the failure to address the three areas. The influence in teaching of the purpose-made support materials in the form of teacher's guides, textbooks, and pupils worksheets have been inadequately investigated. The dearth of teachers' views on their practice is conspicuous in the report. Nevertheless, the overt routines in teacher-pupil interactions have been sufficiently covered.

A brief review of the second generation of sources resulting from the study follows. The sole purpose of the section is to reconcile the data from the report with that in the various international journal publications made by Prophet and Rowell.

2.2.2.3 Reconciling the report with journal publications

Unlike the report Prophet and Rowell submitted to the sponsors of the project, the journal publications have become widely accessible. Their three key international journal articles are: "Rhetoric and reality in science curriculum development in Botswana" published by Prophet in 1990; a co-authored article in 1990 by Rowell and Prophet entitled "Curriculum-in-action: The 'practical' dimension in Botswana classrooms", and "Coping and control: science teaching strategies in Botswana" which was published in 1993 by the duo. They contributed chapters to a number of books published locally in Botswana. Nonetheless, the three journal articles cover all key sections of the study and report. In reconciling the articles with the report, a few noteworthy observations are revealed.

One observation is that in terms of content (i.e., illustrations, research findings, research methods), the articles closely match the information in the report. The only difference is that the interpretations in the report have been developed extensively in the journal articles, amplifying and clarifying the research findings. The second observation is that information on the composition of teaching force in schools in general, is given. The problematic supply of qualified local teachers, together with the then "fairly substantial dependence on expatriate teachers" who were often British, Indian, or American Peace Corps volunteers (Prophet and Rowell, 1993, p. 209), is noted. The research sample itself "consisted of a mix of local and expatriate teachers" with local teachers being "relatively highly qualified, having graduated from rigorous teacher training programmes at the University of Botswana or Colleges of Education which emphasise student-centred approaches in the classroom" (ibid., p. 197). The report of the study did not reconcile the latter fact with the 'teacher-centred' implementation of the student-centred ideal curriculum. Nor did the report account for any aspects of practice observed with expatriate and local teachers. In summarising their research findings, Prophet (1995) state that they "found that

contrary to curriculum statements, classroom instruction remained predominantly teacher-centred and authoritarian with passive students engaged mainly in recall learning" (p. 128).

Prophet and Rowell's study was dogged by methodological problems both in data collection and in its analysis. With the researchers engaging in data collection in two days per week over a sixteen-month period, this works out to about 40% engagement over the entire period. This was inadequate for an ethnographic study as reflected in gaps in data as discussed in this chapter. Close attention was also paid to Prophet and Rowell's explanations regarding their field observations. As it turned out, the explanations were speculative and thus did not follow directly from analysis of field data.

Having considered Hamilton's and Prophet and Rowell's studies, the next section attempts to create links between them and my study.

2.3.0 Linking the Reviewed Studies with this Work

Hamilton's study at Simpson and Maxwell Schools provides a vital link between it, Prophet and Rowell's study and mine. The conditions at Maxwell School, which were new with teachers committed to implementing the curriculum, were reminiscent of the conditions which Prophet and Rowell found in their research environments. CJSS's were fairly new when Prophet and Rowell's study was conducted. This also coincided with a high influx of newly qualified teachers from the Molepolole College of Education. The college was established as part of the reforms in education. The fitting of the curriculum to existing structures at Hamilton's Simpson School is similar to what happened at the time my study was conducted. A new three-year curriculum was fitted into a set-up designed for a two-year curriculum. As the research findings will show, enormous organisational and pedagogic arrangements were necessary to accommodate the new curriculum. The other similarity between the three studies is that, in broad terms, they are all based on qualitative observational strategies and are conducted within the first two to three years after the respective curriculum was introduced into schools. In all three cases, teachers were still exploring and familiarising themselves with the curriculum materials.

However, in terms of methodology, my study seeks to surpass the other two studies. It is based on case study strategy and aims for strong ecological validity of data and findings. This is promoted through prolonged contact with the research environment and through interviews with teachers. The research findings will be placed in the wider context of the literature as a way of acknowledging and recognising the wider socio-political factors which impinge variously on curriculum implementation. The study also seeks to give explanations which are firmly grounded in data as in Hamilton's case, as well as being speculative as in Prophet and Rowell's study. A strong interplay between data and explanations will thus be promoted.

2.4.0 Summary

The purpose of this chapter was to locate the study in the field of empirical studies conducted during the establishment phase of the implementation of integrated science schemes. They are Hamilton's and Prophet and Rowell's studies. The studies are also important in this work as they provide a starting point for understanding what happens to curriculum upon its introduction into teaching environments. However, Hamilton's study focused on organisation of teaching in science departments while Prophet and Rowell's study concerned itself with the curriculum-in-action. The two studies also provided insights and reflections into the various methodological concerns which helped to inform the formulation of the methodology for this study. The two studies have thus helped to define the position of and to contextualise my study which is also exploratory and observation-based. The next chapter explains the methodology followed in this study.

CHAPTER 3

METHODOLOGY

This chapter seeks to explain the research strategy for empirical data collection for the study. It also explains what was done in the field and how. The chapter comprises several sections. Vital background information about the research environment covering sample choice and size and the time-frame of the study comprise the first section.

The second section gives a description of the case study research strategy used in the study. It also entails defining the 'case' by way of specifying the bounds for the investigation. My role and position in the fieldwork as a participant observer is discussed under the section on methods for data collection. The final section of the chapter considers access negotiation and the associated research ethics which had to be observed. This helps to place the data in the proper context.

3.1.0 Overview of the Research Environment

The overview is in two sections. The first section provides some statistics and information about research participants and the time-frame of the research. Appendix 4 cites detailed information about the research environment. The second section provides information about choice of the research site and how it relates to methodological considerations for the study.

3.1.1 Statistics and background information

A total of eight schools and 26 teachers were involved in the study. Pupils' enrolment in the eight schools, each with 18 streams (i.e., classes), ranged from 596 to 777. The average class size ranged from 33 to 45 pupils with their ages ranging from 13 to 15 years. Appendix 4 shows the respective school enrolment figures for 1996-1998 and provides some explanations for variations in enrolment. The distribution of teachers by school, age and teaching experience is as shown in the Appendix.

The predominant age-group had 11 teachers in the 25-30 years age bracket. They all had teaching experience ranging from 1-5 years. Nineteen of the 26 teachers held Diplomas in Secondary Education and 17 were from the Colleges of Education. The other two were from the University of Botswana. All other science teachers, three of whom were deputy Heads, had Bachelors degrees in science education. The deputies taught because of a shortage of science teachers in their respective schools. The 26 teachers excluded three expatriate teachers whose teaching contracts with the government expired in December 1997; the five new graduates on first appointment as teachers who came into schools in January 1998.

The fieldwork had two complementary phases which were not designed, but which arose from the organisation of the school calendar. A school term comprised 14 weeks which defines a phase. Phase 1 ran from September to December 1997. It was separated by a 6-week school Christmas vacation from Phase 2 which started from January to April 1998. The conduct of research in the two phases was similar. However, Phase 2 built on refinements of approaches used in the previous phase which resulted in the increased selectivity and focus of data collection. The other difference was integral to the school terms themselves: Phase 1 was in term 3 of the tri-semester school calendar in 1997 and Phase 2 was in term 1 of the 1998 school year. Overall, a total of 69 lessons, giving a combined total of 92 hours, were observed in both phases of the study. At the end of Phase 2, some relatively less formal contacts were made with schools as attention was focused on the collection of documents from the Ministry of Education.

An abridged time schedule illustrating key episodes in the field is shown below. Appendix 4 (section 4.4.0) contains the detailed version. The time schedule simply placed data collection within the time-frame of research.

- | | |
|-------------|---|
| May 1997: | Access negotiation: written requests from York sent to school Heads and the Permanent Secretary at the Ministry of Education in Botswana. |
| Aug. 1997: | Physical follow-ups of the requests. Meeting school heads. Research Grant for £1200 approved by my sponsors. |
| Sept. 1997: | Phase 1 of data collection begins in mid-September. |
| Oct. 1997: | Progress report despatched to my supervisor at York. |
| Nov. 1997: | End-of-year school-based examinations begin. Temporary withdrawal from the field. Preliminary data analysis and reflection on the study undertaken. Report prepared for the consultative meeting with supervisor. |
| Jan. 1998: | New school-year and Phase 2 of data collection begins. Attended a 4-day conference in Pretoria (South Africa), the venue for the arranged meeting with supervisor. |

- Apr. 1998: Schools close for the Easter vacation (3 weeks). Phase 2 of research ends.
- May 1998: Gradual withdrawal from the field. Schools visited infrequently. Collection of documents from the Ministry. Meeting with Inservice Officer. Report on research expenditure submitted to my sponsor.
- Jun. -Aug. 3 months rest and break from data.
- Sept. 1998: Returned to York for data processing.

3.1.2 The research site

This section focuses on explaining and justifying the choice of the research site. As stated in the overview of Botswana (Appendix 1), the country has disparate environments namely, rural and urban. The huge differences in the socio-economic and socio-political aspects of these environments impinge variously on the provision and quality of education. This justifies sensitivity to research in the areas and is explained in this section. The discussion here briefly considers differences between the two types of settlements and their implications to research.

Urban centres are fairly recent in the history of Botswana. The development of the capital city, Gaborone, started after independence in 1966. There are at least five other key urban centres. They are: Lobatse; Jwaneng, Selibe Phikwe, Orapa, and Francistown. There are also at least eight 'tribal towns' each associated with a particular 'principal' tribe. The disparities between the two types of settlements are vast with the 'tribal towns' being big traditional villages while, on the contrary, urban centres are Botswana's metropolitan areas with cosmopolitan populations and diverse economic sectors. The disparities posed implications for the choice of research site for the study. A decision was taken to work in a tribal town some 50-60 km from Gaborone. The typicality of the environment, in which the eight schools comprising the research population are located, is explained briefly.

Being a developing country, almost 80% of the population of Botswana lives in the rural areas where subsistence agriculture (both pastoral and arable) is the main economic activity. Unemployment is relatively high. Though the country has generally developed tremendously in the last 30 years, the rural areas in contrast to the urban centres have responded rather slowly and conservatively to change. The tribal towns, also known locally as 'tribal administration centres', are developed by the government and are strategically located to extend essential services to large hinterlands of satellite villages (a settlement is given a village status if it has at least 500 inhabitants) accessible mainly through dirt roads. The satellite villages themselves, which are

rather scattered and sparsely populated, epitomise life in tribal capitals. A primary school, a health centre, scores of small grocery shops and, perhaps, a CJSS serving aggregates of isolated villages, characterise a typical and affluent satellite village. On the other hand, tribal towns, with about 40 000 inhabitants would have several primary schools, about eight CJSS, a senior secondary school, chain retail shops, one or two banks, health centres, a district (referral) hospital, and the 'tribal' administrative offices: all these have left the traditional way of life relatively unchanged.

All state schools are tuition-free and run by the government through the Ministry of Education. And, with the government policy of transferring pupils across level of education to schools nearest to a pupil's previous school, one can receive education in one tribal village. In contrast, the urban centres with a high concentration of the rising middle and high class groups in Botswana have led to the emergence and rapid growth of mainly private primary schools, labelled English-Medium schools. Historically they were so-called because they catered predominantly for children of expatriate personnel and English was their medium of instruction. However, the rise in the number of private schools was not matched by the increase in private secondary schools, resulting in the bulk of the pupils from the private primary schools being enrolled in state-run CJSS in urban centres. This means that schools in urban centres cannot be taken to be typical of conditions in which the bulk of pupils in Botswana received their education. This is an essential consideration, particularly in a study which seeks to capture the realities of implementing a context-dependent curriculum. It was for this reason that the study was conducted in eight CJSS in one tribal capital.

A number of key considerations, all vital to methodology, also influenced the decision to work in one locality. They are:

- a) Schools are within the same macro-contexts (e.g., political, socio-economic, and regional education administration) though no two or more schools are identical;
- b) Students are from the same pool of feeder primary schools in the region. They are also of generally and predominantly the same ethnic or tribal group and share similar socio-economic and socio-political backgrounds;
- c) Tribal towns, sometimes referred as semi-urban environments, are a compromise between the extremes of rural and urban settlements. However, in terms of socio-economic status and lifestyles of the inhabitants, tribal towns are more rural than urban;
- d) Also, the fact that the study is conducted exclusively and over a long period in one area means that chances are enhanced for unearthing subtle data which a 'survey', involving a large sample from different environs may otherwise gloss over.

Overall, observing the above four factors means that the ecological validity of the data is enhanced and that the complexity in data analysis that could result from drawing a large sample is reduced. The factors were thus some of the key considerations in planning this study.

This leads to a consideration of perspectives on methodology adopted in this study, which is done in the next section.

3.2.0 Research Perspectives

This study is concerned with understanding the implementation of science curriculum in the participating schools. The interest is classroom transactions and the various activities which are taken to symbolise curriculum-in-action. Briefly, the study is located within the interpretive paradigm where purpose and meaning are assigned to actions of teachers and pupils (cf. Power, 1977). The basic tenet guiding the study is that "classroom interaction is assumed to be an interpretative process in which meanings evolve and change depending on the context of what has gone before and what is expected to follow" (ibid., p. 20). Operating from such a position, an explanation of case study approach is made as well as the methods for data collection.

3.2.1 Case study approach

A 'case study' is widely characterised as a research strategy (see Simons, 1989; Atkinson and Delamont, 1985; Crossley and Vulliamy, 1997). A research strategy is essentially a paradigm (cf. Crossley and Vulliamy, 1997, p. 5) with a defined tradition, structure and attributes identifying it either with a positivist or non-positivist research traditions. From the literature, a case study or studies is characterised as a 'holistic' research undertaking for purposes of detailed examination of phenomena in context over a long period of time and through a wide selection of data collection and analysis methods (Bogdan and Biklen, 1992; Sarantakos, 1994; Nunan, 1996; Merriam, 1988; Anderson and Arsenault, 1998; Simons, 1989). Some of the widely cited definitions of case studies consistent with the understanding guiding the study state that:

A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used (Yin, 1984, p. 23).

... the qualitative case study can be defined as an intensive, holistic description and analysis of a single entity, phenomenon, or social unit. Case studies are particularistic, descriptive, and heuristic and rely heavily on inductive reasoning in handling multiple data sources (Merriam, 1988, p. 16).

However, qualitative case studies have widely been seen to share similar attributes with ethnography (cf. Nunan, 1996). Basically, ethnography is a generic term for the genre' of those studies which are cultural or anthropologically-based (Wragg, 1994) and which seek to understand phenomena in its natural context. The inter-relatedness of case study and ethnographic

methods, which seem practically to lie on a single continuum, has been recognised and widely exploited in schooling and policy studies in education. See for instance, Wilson (1977), Spindler and Spindler (1992), Woods (1979), LeCompte *et al.* (1992) and, Delamont and Galton (1986).

However, it is clear from the literature that case study research and ethnography, while sharing some theoretical and practical attributes, are epistemologically different (see Atkinson and Delamont, 1985). Nonetheless, Stenhouse (1983) has identified several types of case studies, amongst them the '*neo-ethnographic*', literally meaning a modern form of ethnography though the position does not commit itself to the sameness of the two areas. However, based on the realities of the research environment, an ethnographic study was also considered as an equally viable way of studying the implementation of the curriculum. The problem was the relatively short time available for research which would not satisfy the requirements of a study characterised as ethnographic. The decision to fully consider and explore ethnography as an alternative research strategy (e.g., in my original research proposal), was proper. As Rist (1979) states:

The decision on the style of research one chooses to employ should be a matter of informed judgement, not of orthodoxy. To do otherwise and become so enamored of one method to the exclusion of any other so that the method becomes an end in itself is the antithesis of enlightened study (pp. 17 - 18).

Finally, in adopting a case study approach in this study a commitment was made to the following four key positions:

Case study research attempts to reach understanding through the detailed study and portrayal of individual instances, persons, ideas, institutions and events (Alderman and Walker, 1975, p. 226);

Case study ... recognises the particular contexts in which innovations are embedded and aspires to describe and analyse the processes by which and the conditions in which innovations are implemented. Case study is not a method as it is sometimes assumed, but a focus of the study, whether that focus be a single classroom, institution or system. The essential feature is the case (Simons, 1989, p. 114); and

The reality to be investigated, then, is a complex social reality in everyday life in institutional settings. The emphasis is firmly - even exclusively - on 'process' rather than product or outcomes (Atkinson and Delamont, 1985, p. 27).

Generally, the case study approach seems to offer the adaptability and flexibility needed for inquiry into curriculum implementation which is a relatively unexplored area in Botswana.

The fourth position relates to categorising the study as *qualitative*. This locates the study in a research tradition which Rist (1979), citing Filstead, explains thus:

Qualitative methodology refers to those research strategies such as participant observation, in-depth interviewing, total participation in the activity being investigated, field work, etc., which allow the researcher to obtain firsthand knowledge about the empirical social world in question. Qualitative methodology allows the researcher to "get close to the data", thereby developing the analytical, conceptual, and categorical components of explanation from the data itself (pp. 19-20).

In presenting the crystallised view predominant in the literature, Mason (1996) states that qualitative research is broadly 'interpretivist', and places "more emphasis on 'holistic' forms of analysis and explanation in this sense, than charting surface patterns, trends and correlations" (p. 4). The 'reality' captured in qualitative strategies is located in what Lincoln and Guba (1988) call the "relativist ontology". Under the paradigm, "reality is multiple; those multiple realities are the constructions made by human actors involved, and there are as many realities as there are actors. Those realities exist in the minds of their constructors; thus they cannot be broken apart but must be examined holistically" (p. 93).

The views expressed above are widely shared and common to the literature on qualitative research. See, for instance, Bogdan and Biklen (1998); Sarantakos (1994); Crossley and Vulliamy (1997) and, Miles and Huberman (1994). The position adopted here approximates the utilitarian, functional, and not the prescriptive understanding or definition of qualitative research. All eight schools are taken to be one research sample for the case study. The link between the qualitative case study approach and the study of phenomena (i.e., implementation of curriculum) is made by focusing on one caveat of the approach and on some assumptions of the study. This defines further both the "case" and focus of the work.

It appears that one caveat that tends to characterise qualitative case studies is that the bounds of research are typically implicitly defined by the research questions. This could be a consequence of the flexibility of case studies where honouring the rigours and demands of methodology seems to be the main guiding principle of research. The explorations, characterised by collecting data within the scope defined by the researcher, makes it difficult for a typical case study to be faulted. Borrowing the expressions used by Heritage (1980) (cited by Stebbins, 1981, p. 274) to express the problem, the "operational sense of context" of the observer is "indefinitely extendible". Or, as Furfey (1965) would say, 'the universe of discourse' or context might remain weakly defined in some instances. The attempt to solve the problem, and thereby to limit and define further the scope of the study, was done through focusing exclusively on schools as research sites, classroom observations and teachers' views both expressed in interviews and informal discussions. Except where stated otherwise in the study, Officials at the Ministry were excluded. This further defines and qualifies the interpretation of implementation as a key concept in the study. "Implementation" in data collection is that observed in class and does not, therefore, encompass curriculum dissemination by officers at the Ministry.

One compelling argument against including the officers is based on Thrupp's (1998) notion of "politics of blame". This involves an uncompromising stance on schools' performance in which the quality of implementation is seen in terms of school policies and teacher practice and any reference to broader socio-political factors might be ruled out as excuses (cf. Thrupp, 1998, p. 196). In other words, the officers are removed from classroom realities and cannot give authoritative accounts about what happens in schools. Furthermore, "all beliefs and actions - even those regarded as deviant or weird - [are] instead assumed to be rational, to be the product of competent reasoning" (Hammersley and Woods, 1976, p. 2). In attempting to capture classroom reality during teaching efforts were made to create a strong link between the actors, the 'where', the 'when', the 'how' and the 'what' question with the 'why' questions (cf. Hargreaves, 1984, p. 66). This defines not only the general framework of operation but also the main concentration area in data collection in classrooms.

However, there are two key consequences of adopting the above questions. First, and appropriately, the focus is on the "operational curriculum ... the actual instructional process in the classroom" (Goodlad *et al.*, 1979). That is, on the processes rather than on outcomes or on products of interactions in the course of the implementation of the curriculum. This selectively and decisively identifies the study more with the *process* than with the *fidelity* perspective (Fullan, 1982; Fullan and Pomfret, 1977). The latter perspective, associated with what Eggleston *et al.* (1975) calls *matching* studies, seeks to make a comparison in data collection "between a teacher's behaviour and that behaviour which is consistent with a prescribed curriculum" (p. 4); or rather, on whether compliance has taken place in line with the intentions of curriculum developers (Fullan, 1982, p. 31). On the contrary, the *process* perspective (Fullan and Pomfret, 1977) focuses on what happens in the classroom when the curriculum is implemented and seeks explanations from the contexts and the users (teachers) themselves. The concern in data collection, and hence the study, is thus not with the realisation or otherwise of the rhetoric of the curriculum.

Consistent with an observation by Barton and Walker (1981), the second implication is that it is assumed that "it is classroom interaction that mediates and makes sensible the 'text' of the curriculum" (p. 228). The consequence of this to the study is that the "processual perspective to action" defines the notion of 'implementation of curriculum' and thus, defines the scope of the study and invariably, the context or scope within which the case study methodology is used. This leads to discussions on the methods for data collection.

3.2.2 Methods for data collection

Two methods or 'research styles' (cf. Woods, 1979), participant observation and semi-structured interviewing were used in data collection. In this section, the focus is on explaining participant observation, recording of classroom observations and the conduct of interviews.

3.2.2.1 Participant observation

My role in data collection is referred to here as participant observation. This is explained in relation to the range of tasks which I undertook in the field. According to Wilson (1977):

The qualitative research enterprise depends on the ability of the researcher to make himself a sensitive research instrument by transcending his own perceptive and becoming acquainted with perspectives of those he is studying (p. 261).

The notion of 'transcending one's own perspectives' by, for example, immersing oneself in the new culture (Delamont and Hamilton, 1984), is theoretically a possibility but is a near impossibility in practice as "no one .. enters in a situation at true *tabula rasa*" or theory-free (Hammersley, 1983; Delamont and Galton, 1986; Boydell, 1975; Knupfer, 1996; Eggleston *et al.*, 1975). This means entering the field with relative little or no preconceived views of the phenomena to be observed. So the need for open-mindedness was a pre-requisite in the fieldwork.

However, as Edwards and Westgate (1994) rightly observed, "any research can be said to carry with it an implicit view of what is to be treated as significant of a reality to be studied" (p. 74) which was demonstrated by my 'observational focus' on observable classroom interactions. Olson's (1992) position on teacher practice informed and further defined my perception of my activities in the field:

What people know what to do is bound up in what they do, and the meaning of what people do has to be understood in terms of the purposes they are attempting to achieve. Without understanding those purposes we cannot understand what the actions mean ... most teachers do not do the kinds of things for which a mechanical model of their work is appropriate. What they do is sufficiently complex ethically and practically to require a more humane perspective (pp. 46-51).

The above position, widely supported in literature, briefly explains how I adapted myself to become a 'sensitive research instrument'; that is, basically a 'participant observer' in data collection. Chapman's (1986) basic conception of participant observation as entailing "finding a way of spending as much time as possible with teachers and/or pupils being studied" (p. 103) is appropriate in the study as I was not a member of the teaching staff. In class, I was a 'direct passive observer' (Spindler and Spindler, 1992, p. 67), a 'fly on the wall' (see, for instance, Scott and Usher, 1999; Croll, 1986; Coffey, 1996) though Burgess (1985) indicates the untenability of the idealistic or theoretical implications of the labels. As Goetz and LeCompte (1984) explain,

"participant observation is reflexive; it involves researchers studying themselves as well as other participants in a social setting" (p. 143).

In terms of my general field operations, Denzin's (1978) position wherein participant observation is "defined as a field strategy that simultaneously combines document analysis, interviewing of respondents and informants, direct **participation** and observation and introspection" (p. 183), is embraced. My 'direct participation' was restricted by accepting that I might have been a factor in the research environment (see Bogdan and Biklen, 1992; Burgess, 1985; Hammersley, 1983). Recording transactions in class were a crucial task in research as the records formed the basis for interviews and discussions with teachers. The next section elaborates the development of records.

3.2.2.2 Recording classroom observations

Classroom observations were done with Forms 1, 2 and 3 classes in the eight schools. The researcher made contact with a randomly selected class and teacher over six periods of 40 minutes each. The six periods were time allocated for science teaching in a week. Details of class selection are given in Appendix 11 which provides a comprehensive overview of some selected aspects of research.

Observations encompassing teacher and pupil activities, some complementary or explanatory notes meant to preserve "relationships between movements, gestures, affirmation and objective conditions of the situation" (Anguera-Argilaga, 1979) were recorded chronologically on blank sheets of paper. The "low technology approach" (Edwards and Westgate, 1994, p. 77), the pen-and-paper strategy (Goetz and LeCompte, 1984) is widely followed in ethnographic research (see, for instance, Spindler and Spindler, 1992). The classroom observations could be regarded as 'open-ended' and 'unstructured' (L. Hargreaves, 1998; Delamont and Hamilton, 1975).

Nonetheless, the approach was legitimised by the exploratory nature of the study which "demand(s) unstructured methods where the observer can pick up the important features in each teaching situation whether or not they are the same in each case" (Delamont, 1975, p. 109). In view of the nature of the study, the need to capture contextualised data *in situ*, at the time and place of occurrence (Anguera-Argilaga, 1979), and almost verbatim - putting down, as far as possible, what I saw and heard not the impressions received (Furfey, 1965, p. 305) - was important. The rationale for the approach is explained by Hamilton, who in a similar study of implementation of the Scottish Integrated Science Scheme in the early 1970s, had to contend with the paucity of research in the area. He states:

Since there were few related studies available at that time the general tone of the investigation was exploratory. The approach was problem-centred rather than method-centred. In this case, the problem (the need to examine classroom phenomena associated with curriculum innovation) was instrumental in focusing the enquiry. The methods were developed, therefore, as the problem became clarified (Hamilton, 1979, p. 196).

On the other hand, the method of recording the observations was also deemed suitable on the basis of the relatively high reliability and validity it afforded the data. Hurwitz (1979) has devised eight criteria for checking reliability and validity of research instruments, three of which are important for this study. They are:

- (a) "Can the measuring system detect actual differences in the aspects of classroom behaviour it measures in different classrooms? (Reliability and validity);
- (b) Does the system fully measure the aspects of classroom behaviour which it purports to? (Content validity);
- (c) Do the aspects of classroom behaviour the system purports to measure fully exist in actual classrooms? (Content validity)."

(Ibid., p. 112)

More measures for enhancing the validity (see Note 1) of data were built into the schedules (i.e., school visits) and interviews. The key features of the recordings in observation sheets are discussed below as they provide insight into the recordings that were made.

The following three sets of statements, consistent with perspectives informing the study, form a prologue against which the contents of observation sheets are to be understood. The observations were made from the point of view that:

.. classroom teaching was defined as a special case of social interaction carried on via observable verbal and non-verbal communication between the teacher and pupil(s). The overt verbal and non-verbal classroom communication process was viewed as the giving and seeking of various kinds of information by the teacher and pupils. The concurrent occurrence of the process of listening or receiving information was taken for granted (Parakh, 1969, p. 287).

Furthermore,

The unit of analysis chosen was therefore the activity or setting, this term being used to indicate that the teacher has previously made a decision about the range and variety of activities which would occupy the day. In this sense, all settings were teacher controlled, though not necessarily teacher-directed in that they required continuous intervention or supervision (Popleton, 1975, p.248).

And, the last key assumption made in the recordings is articulated by Morrison (1975):

Teachers and pupils are speakers and hearers and the main access to the rules which guide the course of their encounters is through what they say to one another and what they say about themselves. ... Thus, the observation and recording of behaviour of teachers may in itself provide little more than descriptive lumber unless it is viewed either as the means of access to generalisable or particular rules for interaction or is carefully anchored to ... the contexts in which they work (p. 114).

The emphasis was on recording events as they unfolded for each lesson observed. Appendix 5 contains four samples of observation sheets drawn from different classes with different teachers. The samples, drawn from a total of some 69 others, provide contextual material for the reader to visualise the classroom and its associated activities. Data from classroom observations formed part of the large pool comprising various other primary sources (see Appendix 5, section 5.2) used in data analysis.

However, while recording unstructured observations was the main mode of data collection, due to the length of the fieldwork there was a need to avoid unproductive indulgence in the activity. This was very important in Phase 2, since following the analysis of data from Phase 1 it became apparent that some areas were highly covered in the notes while no or relatively little information was available for some. This led to the development of an instrument, contained in Appendix 7, and whose origins and usage are elaborated below.

The development of a semi-structured research instrument was both a consequence of the review and a way of pursuing the research ideals of "progressive focusing" in research. Preliminary data analysis from Phase 1 had shown areas which teachers seemed to place less emphasis on, and these were specifically targeted in the development of the instrument. The areas include, among others:

- a) incorporation of pupils' daily experiences, examples and contributions to science teaching;
- b) teaching illustrations which were 'Botswana-specific'; and,
- c) the *spiral nature* of the curriculum.

The instrument promoted heightened awareness of areas which might have been overlooked in the previous phase. Several advantages were noted. There was provision for observations amenable to quantification. For instance, teacher-pupil verbal interactions, heavily documented in Phase 1. The quantification was intended to ensure that variations in patterns of interaction could be noted. It could, however, be argued that the bulk of the quantified data was not contextualised. Although this is a caveat in data collection, it should be remembered that the instrument was used at a point when much data had already been collected with some heavily emphasised/over-collected. As the study unfolded the need to be selective was inevitable if the data collection were to be focused and productive. The quantification, reducing writing by a possible 40%, was also important in developing a profile for a lesson, which was a helpful factor in interviews. However, the instrument was largely qualitative allowing for qualitative descriptions, prompt concentration and the recording of critical events, *negative instances* and observations. Overviews or mini-summaries of lessons were also made at 15-minute intervals to ensure that the research remained

focused and avoided lapses in recordings. Use of other data sources and interviews for cross-validation of data helped ensure that the descriptions were objective (see Shaw, 1996; Coffey, 1996).

In general, the two phases of the study equate to about 67% coverage of curriculum at Form 1 and Form 2, respectively. Form 3, introduced in Phase 2 of the study, meant coverage of about 33% of the respective syllabus. This meant that the data collected covered broad sections of the syllabus. The teaching of the diverse topics enhanced the validity and reliability of observations. As had been observed and argued, teacher practice in Phases 1 and 2 was fairly consistent despite changes in context and topics being taught. This inevitably resulted in saturation of categories with the monotony in teaching increasing the difficulties of searching for negative instances. Classroom observations were thus terminated at the end of Phase 2.

As the completed instruments used in Phase 2 demonstrated, those areas which were identified as neglected in Phase 1 remained unattended by teachers. This made a case for application of methodological yardsticks for determining the point of diminished returns in research. For instance, checking for saturation of categories, emergence of regularities, and over-extension (see Anderson and Arsenault, 1998; Bogdan and Biklen, 1992; Denzin, 1978). As Guba and Lincoln (1988) state, "given sufficient interaction, the naturalist focuses on the criterion of coherence" (p. 108) in the data as "one can hope for the development of a construction [of reality] that is internally consistent and that respondents will agree is consistent with the several realities that are found to exist in a setting" (ibid.). Furthermore, Anderson and Arsenault's (1998) observation was also in order:

... although it is seldom mentioned in standard works on research ethics, it is unethical to waste participants time by asking him/her to complete irrelevant questions or participate in studies which by nature cannot lead to significant results (p. 21).

The classroom observations formed the basis for interviews whose conduct is explained next.

3.2.2.3 Interviews

Semi-structured interviews were also the main primary mode for data collection. Their position in research is also seen relative to the unstructured observations. As Delamont (1975) explains, "unstructured observation is essential, and, to be confident one has picked up the aspects of the situation which are important to the participant, both formal and informal interviews are necessary" (p. 109).

A 'functional' meaning of interview embraced in this work reads:

It is a meeting of individuals face to face; it is dedicated to a particular purpose, and is embarked upon with the consciousness of this; it employs true conversation; and there is frequently a non-reciprocal relation between the individuals taking part. From these characteristics arise many of the psychological peculiarities of the interview situation (Oldfield, 1947 cited by Furfey, 1965, p. 321).

Interviews were mostly based on observed classroom transactions and sought teachers' views about curriculum and about some aspects on its implementation. The interviews were conducted in seclusion with individual teachers and after their last scheduled classroom observation and were either tape-recorded or hand-written (i.e., an account). Using the two modes randomly throughout the study brought some benefits to the quality of data collected. Recording interviews on audio-tape made the undertaking seem formal (see Vulliamy, 1990c, pp. 104-105) and had to be performed while conscious of the need to keep a low profile and to blend well into the environment (Miles and Huberman, 1984; 1994). The advantage with audio-taped interviews was that they helped preserve the integrity of the data as the conversations captured were available thereafter. Interviews for which hand-written condensed accounts were developed, as Miles and Huberman (1984) would say, helped reduce "both (my) threat quotient and exoticism quotient for informants" (p. 233). The disadvantages with the latter mode of recording are well documented in literature particularly the potential pitfall of developing accounts which are an extension of the researcher's self and identity (see, Shaw, 1996; Coffey, 1996). Because of the selectivity in recording, the integrity of data might be unwittingly compromised. The data solicited from teachers using both modes was, nonetheless, similar in content.

The ability to apply the case study research strategy and the associated research styles was made possible by "gaining access" to the research environment. This delicate process entailed observing various research ethics which not only set standards of what was ethically possible, but also contextualised the data while safeguarding its ecological validity. This is a very important consideration in this study which justifies the lengthy discussion that follows.

3.3.0 Access Negotiation

Access negotiation is defined here as a process integral to research and through which one's acceptance to work *within* educational institutions for purposes of data collection is initiated, developed and maintained for the entire duration of a planned study (Wilson, 1977; Croll, 1986; Delamont, 1992). The basic tenet of my role as a participant observer in data collection was the conviction that access to relevant data necessarily required the creation in the field of favourable social relationships. With the use of multiple sources of data, multiple '*forms*' of access were also required to at least six distinct but inter-related areas. They are:

- a) initial access into schools and subsequently to;
- b) individual science teachers (targeted participants);

- c) teachers - i.e., the wider teaching community;
- d) classrooms;
- e) teachers' perspectives about practice through interviews; and
- f) documents (syllabus, scheme books, test/examination papers, official correspondence).

Discussions concerning access negotiation will focus on initial access to both schools and teachers.

3.3.1 Initial access to schools

Initial access to educational institutions has been widely identified in qualitative research literature as crucial, though probably one of the most difficult aspects of fieldwork (see Troman, 1996; Hitchcock and Hughes, 1992; Bogdan and Biklen, 1998; Delamont, 1984 and 1992; Anderson and Arsenault, 1998). While the various difficulties the authors cited were for educational systems in Europe and North America, they still have some relevance to the study. However, the situation in Botswana required access negotiation to a centre-periphery-managed and centralised education system with a typically strong bureaucratic top-down decision-making pattern in the Ministry. Here, compliance with directives from the Ministry is expected of school Heads and teachers alike. "Coalarchy" is the term Morill *et al.* (1999) uses to define such a setting:

Coalarchic organisation exhibit both centralised authority structures and politicised decision-making routines. They contain well-defined, top-down chains of command ... 'Ruling coalitions' centralise legitimate authority and typically have extensive, vertical patronage networks (p. 62).

This is typical of government-controlled schools in Botswana and was illustrated by the manner in which the permission to undertake the research in schools was granted by Ministry officials.

The process of seeking permission to work in the eight schools was initiated through nine letters: one directed to the Permanent Secretary in the Ministry, others to the individual school Heads. The letters were despatched from York to Botswana by the end of May 1997. The involvement of the Permanent Secretary was consistent with his general responsibility as a right-hand man to the Minister of Education for overseeing and protecting the Ministry's interest in education and in the educational institutions. Thus, it was a procedural and routine undertaking which some school Heads and teachers elsewhere in world would treat with suspicion (see Burgess, 1982, p. 120). As Goetz and LeCompte (1984) state, "top-level approaches have disadvantages, however, researchers may be rejected immediately, or, if accepted, they may become over-identified with super-ordinants" (p. 88). The issue is revisited later in the chapter. However, only one school Head had responded to my request by the end of July 1997 when, in Botswana, a physical follow-up was planned for and undertaken late in August. The delay was due to schools being busy with

end-of-term preparations for a three-week school vacation which started in August, 1997. A visit to the Ministry was a logical starting point. A copy of their response letter showed that the Research Officer in the organisation had acceded my request on 30th June 1997 through a letter referenced E. 11/17 XXII (58). It read, in part:

PERMISSION TO CONDUCT RESEARCH IN COMMUNITY SCHOOLS AROUND X* AND Y* (* village names)

Refer to your letter dated 30th May 1997.

I am grateful to inform you that permission had been granted to carry out research in the Community Secondary Schools as per your request. Please get in touch with the Director of Secondary Education who will facilitate your entry into the schools in question.

Yours faithfully,

K. Kgang (Mr.)

(Research Officer.)

cc: Director, Secondary Education.

(Document, Dated 30/06/97)

In the absence of the Director, a senior official in the Ministry acted on his behalf. He scribbled an informal note on the letter from the Research Officer. It read:

Headmaster CJSS,

Here is self-explanatory note. Grateful therefore you assist accordingly.

M. Kamogelo (Mr.)

(for Director)

27.8.97

(The note was date-stamped with the official rubber stamp to prove its authenticity.)

(Document, Dated 30/06/97)

Two points are noteworthy here. One is that as a citizen of Botswana and in light of the fact that the work was for educational purposes, both were probably strong factors which influenced the Ministry's decision. In the case of foreigners and independent consultants, permission is normally sought from the Office of the President as their activities are seen in the context of the internal security of the country. Similar instances from elsewhere are given by Delamont (1992) and Vulliamy (1990b, p. 40). The second aspect is that the Ministry, having endorsed my request, became my 'sponsor' which, according to Bogdan and Biklen (1992, 1998) is someone or organisation "vouching for the sincerity of researcher's interest as well as character" (see also Croll, 1986; Anderson and Arsenault, 1998). The other sponsor was the Department of Educational Studies, University of York, which allowed the use of the official (crested) letter

head in my original correspondence with both the Ministry and school Heads. The Heads were met within days of getting the permission from Ministry.

Only one of the eight school Heads specifically requested a copy of the letter from the Ministry: others did not even ask if I had it. The impressions on access negotiation itself gained from meetings with school Heads suggested that it was taken lightly, possibly suggesting either that an autocratic leadership style existed in schools, or that the decision made by the school Head should be seen by all his staff to be judicious, informed and authoritative. It could also be that the Heads were relatively less informed of the micro-politics of access negotiation. No Head rejected my request. However, some indications implied that no consent had been sought from teachers as evidenced by the following:

1. One Head said he will **inform** his staff about my research (Motswakwa CJSS, August 1997) ;
2. Another said: "I did not respond to your request because I do not have any objections to you and your proposed research ... Just notify us in advance of your visit so that I can liaise with the Science Department on the issue ... " (Mongwato CJSS, August 1997);
3. One Head acceded to my request after he was briefed by his deputy (Mmirwa CJSS, August 1997);
4. In only one case did the Head, who was an expatriate, want a letter of consent from the Ministry. She was quick to add, however, that it was for purposes of accountability to parents, in particular. Otherwise she had no problems with research in her school (Matiriki CJSS, August 1997).

The four cases illustrated a strong possibility that decisions could be made by a school Head without prior consultation or consent with would-be participants. However, since the meetings with the Heads occurred during a school vacation, they were specifically requested to place my research on the agenda at the beginning-of-term staff meeting. I saw this as a way to publicise my visit to all teachers.

Nonetheless, in taking due consideration of the context of operations of school Head it appears that they were not wholly autocratic. First, there existed a centralised control of schools by the government: a school Head is an administrative officer and the fourth in line of command comprising the Minister of Education; the Permanent Secretary and the Director of Secondary Education. Also, schools are public institutions which the government wants to be as accessible

as possible so they are not detached from the communities they serve. Harber and Dadey (1993) in discussing the job of Head teacher in Africa, using situations in Botswana and Ghana as illustrations, capture clearly how CJSS in Botswana have other functions. They cite cases in which officers from the tribal administration centre, health center and landboard made use of photocopiers in schools in rural areas. In some cases, classrooms were used as temporary accommodation for agricultural trade fair participants. These are two of the many similar cases which shows how schools are considered by communities as some form of 'resource', facility and communal property available for use by the public.

While Boards of Directors and Parents and Teachers Associations existed for each school in the study, their mandate excluded matters on school administration. The two bodies are tools for creating links between schools and the communities they serve. Overall, the school Heads unwittingly became my sponsors within schools. At this point, the first set of hurdles in access negotiation had been overcome hence making way for negotiating 'everyday access to informal groups and individuals ' (Morill *et al.*, 1999, p. 52) within schools. As Delamont (1992) aptly notes:

Access is not negotiated once and then settled for the whole fieldwork ... access is a process, not a simple decision ... Access negotiations are likely to be continuing and may even be continuous and continual (pp. 79-102).

Nonetheless, Croll's (1986) observation on access granted by formal *gatekeepers* (the term is used variously, see e.g., Troman, 1996; Bogdan and Biklen, 1998; Anderson and Arsenault, 1998) is instructive. Croll states that "researchers should be sensitive to the fact that they are moving between levels of a hierarchical system in which they approach the lower levels with the support of the higher levels" (p. 93). This leads to a discussion of how the researcher was introduced to teachers and the various research ethics which were but part of the process.

3.3.2 Access negotiation within schools

Following admission into schools by formal gatekeepers, the next stage in access negotiation invariably involves "charming the respondents into co-operation" (Ball, 1990), of which seeking 'informed consent' is part of the ethics to be respected and upheld (Anderson and Arsenault, 1998, p. 18). Enlisting the co-operation and support of the respondents is further enhanced through being "sensitive to their personal needs and perspectives" and their views of the project and the researcher (Glaser, 1972 cited in Troman, 1996, p. 73). In the process, the researcher is judged with respect to self-management (Delamont, 1992) and one should "seek not excess" (*ibid.*) in finding and establishing one's position in the research setting. This should be negotiated with caution (see Vulliamy, 1990b; Anderson and Arsenault, 1998) for, as Bogdan and Biklen (1992) state, people may vie for the researcher's allegiance, particularly in polarised environments with different power groups. All the foregoing are integral to any qualitative field-based research. My

personal experiences in the field are briefly cited, to demonstrate the sensitivity and the developmental nature of access negotiation.

Early in the fieldwork it became apparent that my presence and research activities in one school had not been widely publicised amongst teachers and some school administrators. One incident involving a deputy school Head suggested the existence of the problem. In retrospect, and with regard to my introduction to the Head of Department (HoD) (science) in that school, it would seem that in seeking to work with science teachers it was assumed that I was not interested in contacts with other school members. The introduction, performed in the school Head's office, was rather brisk:

Head: Mr. X, HoD (science) meet Mr. K. This is the gentleman I told you about the other day. He will be with us for 2 weeks this term. Have you already told teachers in your department about his visit?

Mr. X: Yes sir! I have even made copies of their timetables ...

Head: Mr K, I am now handing you over to Mr. X. ... In case you need anything just see him. OK! Thank you.

(Mathata CJSS, Account, September 1997)

From here I accompanied the HoD to a science storeroom which was occasionally used for preparation by science teachers. A short impromptu briefing session with the teachers was arranged for tea-time. With hindsight, this exclusive meeting and the school Head's initiated and enacted my position in the school for the entire visit: I became a visitor of the science department and not of the school. This had certain implications for my research plan and methodology which considered wider socialisation with staff members to be an appropriate environment for data collection. This was so particularly in light of the amount of time to be spent in individual schools. At the end of the visits and in the second week a planned courtesy call on the school Head which entailed briefing him about my work and making an appointment for the next school visit did not materialise. He was not available and I proceeded to his deputy's office, who retorted:

Well, I don't know much about you. I have always seen you around and thought you had something to do with him. Anyway, I will tell him you called his office and you are gone...

(Mathata CJSS, Account, September 1997)

Apart from showing that bureaucratic formalities of access negotiation were inadequate in information dissemination and in reaching all the stake-holders in the school (including informal gatekeepers), the social distance and isolation that had existed between me and most teachers perhaps clearly signalled difficulties with my access into the school. The following metaphor captures the experience well:

Members of a particular group have, as it were, been equipped with a variety of viewing devices - rose coloured spectacles for some, magnifying glasses and binoculars for others; some, it might be thought, have periscopes with distorting mirrors ... (Hayter and Jackson, 1978, p. 14).

The experience was used positively to influence other school Heads to introduce me to all staff members in their respective schools. I usually worked from staff-rooms which maximised contact with all teachers in a given school. I consider the communal tea-breaks in the staff-rooms to have been effective in promoting links with teachers. The tea and confectionery offered was a courtesy and a welcome gesture of which I had to be very grateful. Small conversations about studying and living overseas also helped break the social distance between me and my hosts. Clearly, the change in relationships established in the field across different schools is noticeable.

My self-management and impression skills also changed such that the socialisation with the wider teaching group (i.e., staff members) helped reduce the potential threat (or *threat quotient*) to teachers (see Delamont, 1990; Miles and Huberman, 1984). And as Stephens (1990) has observed from his experience in Nigeria, "it goes without saying that bringing to fieldwork relations, behaviour and attitudes that take account of cultural norms .. eases many a difficult path" (p. 147). Lewin (1990c, p. 142), with experience gained in Sri Lanka and Malaysia and, Anderson and Arsenault (1998, pp. 193-195) with Canadian experience, both emphasise the need to promote research that is desirable socially without negating the wider community's perspective of their reality. This is a further aspect of access negotiation developed during the fieldwork. While the field relations were favourable for data collection, a number of ethical issues surfaced. These are discussed below.

3.3.3 Research ethics and field relationships

Simons (1989) and H. Burgess (1985) have elaborately covered issues on the ethics of case study research in education. The issues they raise will not be repeated here. This section is restricted to those significant ethical issues which arose during the course of the fieldwork.

While permission to work in schools granted by both the Ministry officials and school Heads was needed, my introduction to schools raised some ethical issues. One ethical consideration, based on humane grounds, is that science teachers seemed to be treated as powerless functionaries in a system requiring high compliance with instructions. Though they were informed of what the research entailed, this followed the decision by higher authorities for them to participate in the research. They were thus denied the freedom to choose between participating, staying out, and, according to Eisenhart and Howe (1992), participating with a freedom to "withdraw(al) from research at any time and without penalty" (p. 661). Consequently, all science teachers in each science department participated, with the exception of those excluded by the researcher. The second ethical consideration is that participants might have not been fully aware of what my study entailed prior to my briefing meeting with them. At the time of the meeting it was probably

morally late for their withdrawal, as that might also have embarrassed the school authorities. The appropriate ethical code in this case is called informed consent (Anderson and Arsenault, 1998; Bogdan and Biklen, 1998). However, my briefing sessions touched on issues of confidentiality; the exclusive use of data for research and publications; the conduct of classroom observations and interviews and length of study. This was consistent with the "traditional official guidelines of ethics of research" (Bogdan and Biklen, 1998) particularly those emphasising "understanding the nature of study and the dangers and obligations that are involved (and that) subjects are not exposed to risks that are greater than the gains that they might derive" (p. 43).

While no assessment of risks or benefits to participants was undertaken prior to or during the study, it would seem that the difficulties and challenges which teachers experienced in the implementation of the curriculum were a key factor which motivated them and made them enthusiastic research participants. The challenges and difficulties, unknown to me at the time, have been discussed in the chapters on research findings. Also, the sustenance of relationships with participants seemed to have been indirectly facilitated by the general, though not shared, concern we (i.e., researcher and participants) seemed to have about the curriculum. As one teacher said:

... we have long been waiting for this, to see a citizen undertaking a project which will hopefully inform us of the status of teaching science in Botswana.
... all we have had in the past were people coming in with questionnaires...
We are glad you will be here with us...

(Mrs, Informal discussion, Phase 1)

More evidence of teachers' interest in the study is available. For instance, one of the three deputy Heads who taught science expressed interest in learning the outcomes of my research, and added that she would like to know the status of science teaching in the region. Earlier she had inquired whether the Teacher Assessment Schedule developed by the school could be of use to me. On the other hand, teachers also requested feedback on teaching and lessons observed, showing their positive attitude to the study. For others, I emerged as a confidante'. For instance, during interviews some teachers requested that I switch the tape-recorder off as they felt their views were sensitive. Others raised concerns about the Ministry. For other teachers I was also seen as a subject and pedagogic specialist. For instance, teachers who asked for 'demonstration lessons' for teaching workshops included those who had experienced conceptual difficulties during observations.

While facilitating working relationships and the access negotiated with individual teachers, all the above factors weighed heavily on me and raised some unanticipated ethical issues. In terms of data collection, I had to resist entanglement to a point where my world and the participants' were 'similar'. This led to some tension: on one hand, sympathy and empathy were desirable while, on the other hand, retaining a sense of self and individuality was also necessary. As Wilson (1977)

noted, "the researcher must develop a dynamic tension between the subjective role of the participant and the role of observer so that he is neither one entirely" (p. 250). This put me on a collision course with the ideals of anthropological research which argue strongly against maintenance of one's sense of self and professional identity: I had to avoid "going native" (Denzin, 1978; Hopkins, 1989; Miles and Huberman, 1984; Delamont, 1992) as well as getting caught-up in a 'storm'. For instance, it is stated in Chapter 7 that I considered the situation, particularly the work relationship between the Inservice Officer and the teachers, to have been too hostile, fragile and precarious to allow hosting workshops or demonstration lessons for teachers *en masse*.

However, my stand-off raised one ethical and moral dilemma. The dilemma concerns the question of what to do when participants have a reason to believe that the researcher is in a position to or has the potential to offer the advice that is genuinely needed, but which the researcher withholds to preserve the ecological validity of the data. This highlights the difficulties centred on knowledge differences between the researcher and the researched. In extreme cases, the participants could feel humbled by what they consider to be their modest knowledge. Anguera-Argilaga (1979) explains:

The situation of the observer is liable to create conflicts within himself which may be a hindrance to objectivity. This is especially true in the case of observed subjects who are involved in some kind of emergency, when there is great pressure on the observer to become an active participant, to the extent that he abandons, at least temporarily, his special position as observer. If he does not succumb to this, he may feel guilty for not having given help when it was needed, while, on the other hand, if he becomes fully involved in the activities of the group he may develop a fear of losing his personality as a scientist (p. 456).

A further extrapolation of this dilemma is that the participants unwittingly over-valued or inflated the perceived gains which they genuinely believed would accrue to them as a consequence of participating in research. While this did not necessarily result in distortion of data, it possibly had an impact on the expectation and morale of the participants. The ethical problems and challenges also pervaded every other aspect of data collection, and later, data analysis. Here it suffices to say that the teachers' frustrations with the education system seemed frequently to be reflected in practice. Some of the observations are sensitive and cannot be reported in this work. As Croll (1986) aptly advises:

Any research involves a degree of intrusion into other peoples' lives ... great care should be taken with regard to reporting anything which can damage individuals ... researchers should be aware that subjects may not have the appropriate experience to be the best judges of what might be damaging to them. The consent of the subjects does not relieve the researcher of the responsibility in this area (p. 94).

As part of the wider ethic of protecting damage to schools and participants, no names, peculiar features or identities, and documents which could be traced to a particular school or individual is incorporated in this study. This also includes the restricted use of official correspondence collected in schools. The permission to incorporate it in the study had not been sought from its originator(s). However, in general, it would seem that the access negotiated and granted by authorities did not create difficulties in developing relationships in the field, despite the ethical concerns.

3.4.0 Summary

This chapter has been concerned with the description of the key methodology perspectives guiding the study. As Yin (1994) states, case studies are used when "the investigator has little control over events, and when the focus is on contemporary phenomena within some real-life context" (p. 1). The presentation, therefore, centred on those key issues which are central to understanding both the data collection strategies and the outcomes of the study.

From my position, access negotiation and ethical issues in this study were made a rather sensitive undertaking due to the 'stressed' situation teachers found themselves in as they were exploring both themselves and the curriculum during its 'establishment phase'. The fact that none of them displayed resistance to the research and were always willing and open to participation suggests a situation where one should always be on-guard in terms of research ethics.

The next chapter contains a discussion of procedures for data analysis.

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Notes: Guba's (1981) alternative conceptions of the terms validity and reliability within a naturalistic paradigm are as follows:

Aspect	Scientific term	Naturalistic term
Truth value	Internal Validity	Credibility
Applicability	External Validity	Transferability
	Generalisability	
Consistency	Reliability	Dependability
Neutrality	Objectivity	Confirmability

However, the literature on qualitative research generally embraces the scientific terms more than their naturalistic equivalents or cognates. No reasons for this observation can be found. I will stick to the scientific terms, not for sentimental reasons or conformity, but because they appear to be highly precise and slightly more 'sophisticated' than the naturalistic terms which might be confused with those used in day-to-day discourse.

CHAPTER 4

DATA ANALYSIS

The purpose of this chapter is to present both the theoretical perspectives guiding data analysis and the routines or procedures adopted in the analysis.

The analysis of data was taken to be continual and integral to fieldwork (Denzin, 1978; Bogdan and Biklen, 1992, 1998; Wragg, 1994). The principles and procedures for data analysis are, therefore, a key component of research methods for the study. A retrospective and detailed analysis followed the fieldwork and led to the development of four chapters of the research findings. The focus of this section is on four chief areas: induction as a key framework for analysis, triangulation as a principal tool for data validation, the development and use of a data coding or categorising scheme in the analysis, and presentation of research.

4.1.0 Induction

Induction is taken to be the central principle guiding the study and affecting the way data was recorded, analysed and interpreted. However, induction involves the use of deduction, and the two are inseparable (Furfey, 1965; Strauss and Corbin, 1990). Here the discussion focuses on the adopted interpretation of induction or on its operationalisation as it applies to this study. Basically, induction was taken to be a process involving the collection of a comprehensive array of data (Eggleston *et al.*, 1975) leading to the development of empirical generalisations (Furfey, 1965) which, when refined, result in a descriptive model (Bogdan and Biklen, 1992, 1998) and/or in substantive conclusions (Tesch, 1990) encompassing all relevant cases of phenomena under study. The primary research concern was therefore mainly collecting and making available relevant information for analysis through a process of abstraction. In this case, the understanding or knowledge of implementation of the curriculum is acquired by considering a wide range of experiences, both of the participant observer and informants (i.e., teachers).

There exist, however, other key qualitative approaches in which induction is a key element. These are: analytic induction (Goetz and LeCompte, 1981; Bogdan and Biklen, 1992, 1998) and grounded theorising associated with Glaser and Strauss (see, for instance, Turner, 1981). Hammersley, Scarth and S. Webb (1985) see the two as different strands of the *comparative method* with grounded theorising being primarily concerned with the **development** and analytic induction the **testing** of theory (p. 56). The two methods are paradigmatic in qualitative research and have received extensive reviews in the appropriate literature. For instance, see Denzin (1978); LeCompte and Goetz (1981); Goetz and LeCompte (1984) and Bogdan and Biklen (1998) for analytic induction. Denzin (1978); Turner (1981); and Tesch (1990) contain some discussions on aspects of the constant comparative method.

In contrast with induction as adopted in this work, analytic induction and grounded theory approach both demonstrate hypothesis formulation and testing as their key steps. Time is a crucial factor in hypothesis formulation and testing, as is a significant understanding of and familiarity with the environment. These should follow possibly from a preliminary but relatively exhaustive study and analysis leading to a proper identification of significant lines of further inquiry. Furthermore, the two methods use 'theoretical sampling' procedures to decide on informants or instances from which specific data necessary for re-definition or re-formulation of explanations can be collected. While trends were identified in the field, data confirming or negating themes arose 'naturally' from the routine visits which were themselves random. In summary, the method adopted in this study displays substantial overlap with analytic induction and constant comparative method, though it had its own rigours and levels of abstraction tuned primarily to the focus and dictates of the study. This will become more apparent in the section dealing with data coding and categorisation.

4.2.0 Triangulation

Triangulation is widely interpreted in the literature as an act in which a given phenomenon is seen from multiple perspectives from different sources (Miles and Huberman, 1984, 1994; Bogdan and Biklen, 1992, 1998; Anderson and Arsenault, 1998; Hitchcock and Hughes, 1992; Denzin, 1978). However, triangulation is a fairly flexible and context-dependent process (Hitchcock and Hughes, 1992) though "it confuses more than it clarifies, intimidates more than enlightens", asserts Bogdan and Biklen (1998, p. 104). The purpose of this section is, therefore, to explore how triangulation was perceived and manifested during the course of the fieldwork and data analysis. Streamlining was also necessitated by the fact that teachers were the predominant source of data via both their teaching activities and interviews.

A somewhat 'radical' understanding of triangulation which appears consistent with the study is given by Edwards and Westgate (1994). According to them, triangulation "has its philosophical basis in phenomenology. Reality is seen as residing, not in any would-be objective account separable from the participants, but rather in their respective perceptions" (p. 76). Wilson (1977) elaborates on the benefits of adopting the position:

By systematically seeking to understand actions from different perspectives of various groups of participants, the researcher avoids getting caught in anyone outlook ... He is able to view behaviour simultaneously from all perspectives. The tensions in points of view - between the outsider and insider and between groups of insiders - keep the researcher from lapsing into subjectivity (p. 259).

Triangulation was also broadly interpreted as "a data confirmation technique in which data are strengthened where the same results are produced by different procedures" (Croll, 1986, p. 176). Equally important to this study is the fact that triangulation served "to give greater depth to data

According to Tesch (1990),

The purpose of coding is to aggregate all data about the same topic or theme, so that each category can be seen individually ... the organising system must be refined ... checking appropriateness of the category is especially necessary every time a new batch of data is gathered. Eventually the refining process stops ... each category contains all the pieces from the entire body that are relevant to the category (p. 91).

Tesch observes further that:

It is important for researchers to be mindful of the distinction between organising as data management and organising as a research result ... an organising system that serves as a tool for data management must be useful for facilitating interpretation, and nothing more than that ... the refining process can be kept to a level where the organising system make meaningful grouping of data pieces possible (p. 14).

The study has already been characterised as inductive and exploratory, and not theory-building *per se*. The implications for this to data coding is that at one level it was, a system for organised and systematic data management and at another level, it was a process of pattern-building aiming for enhanced objectivity and cross-validation of findings. The process of analysis was fundamentally descriptive/interpretive (see Tesch 1990) and had gradually developed during the various phases of fieldwork and was further refined afterwards. The categories emerged intrinsically from data themselves (Bogdan and Biklen, 1998; Tesch 1990). The concepts of saturation of categories and searching for negative instances (Denzin, 1978) were integral to the process of coding. However, compared with what would have been the case, say, with the constant comparative method, the categories were neither rigorously tested against reality *per se*, nor was there an engagement in strict selectivity involving theoretical sampling of "what data to collect next and where to find them" (Tesch, 1990, p. 86).

Strauss and Corbin's (1990) description of 'axial coding' adequately explains the entire data coding process:

.. while coding we are constantly moving between inductive and deductive thinking. That is, we deductively propose statements of relationships or suggest possible properties and their dimensions when working with data, then actually attempt to verify what we have deduced against data as we compared incident with incident. There is a constant interplay between proposing and checking ... verifying inductively what we proposed deductively ... proposed relationships have to be supported over and over again in the data ... not what you think might be out there but haven't come across (pp. 112-113).

The applicability and validity of the coding scheme was independently checked by two people who applied it to four sets of the same word-processed classroom observation schedules. Reducing differences between the coders and myself was the main objective as it is practicably

difficult to achieve the same results (Wilson, 1977; Hurwitz, 1979). It was desirable to have more people involved in the validation exercise: this was hampered by the practicalities of identifying people with keen interest and expertise in the exercise.

Having explained the principles which guided the coding exercise, the next section focuses on and elaborates the mechanics of data analysis, in particular, on how data was organised to permit descriptions and identification of trends. The primary purpose of the exercise was to distil and condense data such that patterns and themes implicit to it could be identified with an increased level of objectivity. Only primary data sources (listed in Appendix 5) were used in the coding exercise. The main challenge faced here was in developing categories which were purely descriptive and in avoiding at some stages, those which were analytical, interpretive or evaluative. Data coding at descriptive level was important as it preserved the original meaning of the data. The coding went through three stages which were not necessarily sequential of Open, Axial, and Selective coding as explained by Strauss and Corbin (1990). Open coding basically led to the development of descriptive categories (Bogdan and Biklen, 1998, pp. 171-177) for further refinement at the level of axial coding. The latter is a higher level of abstraction which, apart from engaging one in active search for emerging themes and explanations amongst others, checked on the internal validity of emerging categories and themes against available evidence. Selective coding was the ultimate stage in the coding process at which evidence illustrating, complementing, disproving or otherwise the emergent themes was identified for purposes of developing a balanced view.

Data codes or categories under which pieces of data were put emerged from the data itself. This is consistent with the *inductive* nature of the study: a "bottom-up or empirically-grounded approach" (Harland and Haynes, 1998, p. 3) was adopted. Research questions were not referred to in order to avoid:

- a) fitting the data to pre-determined criteria or implicit categorising schedule;
- b) restricting the scope of categories and thereby risking losing the richness of the data;
- c) lastly, the *exploratory* nature of the study would have been compromised in the sense that organising the data as per the research questions is akin to testing a hypothesis.

The coding scheme was developed based on classroom observations as the main primary source of data on implementation of the curriculum in classrooms. However, reference was also made to some coding schemes in the literature. This helped in the generation or formulation of possible categories for placing data. The schemes, five in total, are: 1) Ober *et al.* (1971) - categories for "Coding sequences and levels of thinking"; 2) Eggleston *et al.*'s (1976) "Science Teaching Observation Schedule"; 3) Flanders' (1970) classroom "Interaction Analysis Categories"; 4) Amidon and Hunter's (1967) "Verbal Interaction Category System"; and, 5) Kerry's (1982)

and give the research a greater understanding of it" (ibid.). In terms of presentation of findings, triangulation was seen as an act whereby I developed confidence in my own analysis and presented them in such a manner as to enable an independent assessment and scrutiny by other researchers. The systematic use and preservation of primary authentic and uncorrupted sources of data (Furfey, 1965), should facilitate easy access to arguments in my work. As Alderman and Walker (1975, p. 226) and Knupfer (1996, p. 145) have suggested, the possibility of presenting 'alternate interpretations' of particular phenomena as a strategy for triangulation was explored and used where possible. This will be apparent in the next set of four chapters containing the findings of the study.

However, triangulation has its own limitations. One is that triangulated data does not necessarily mean that there is "one, objective, and knowable social reality" (see Mason, 1996, p. 149) "out there that is independent of human perception" (Guba and Lincoln, 1988, p. 93) and can be reached. It means that reality is multiple which is consistent with the "relativist ontology" referred to earlier as one of the key aspects of the study. The other limitation is that pieces of data can stand in isolation in a corpus and extensive data without any other perspective to help check its validity. Nonetheless, in an inductive study, an isolated instance has some significance in data analysis and interpretation. For instance, it might illustrate an event which no one theory could adequately describe (see Knupfer, 1996, p. 146): "the exceptional instance is the growing point of science", asserts Lindesmith (cited by Woods, 1981, p. 284). Croll (1986) elaborates:

... the issue of quantification is that a numerical count of incidents may not give a true sense of their relative importance, and that a single event may be more significant than a large number of other occurrence, or, and this may be a more important point, may provide a key insight into the processes being described (p. 165).

The above position has been particularly important during analysis both during and after fieldwork. The issue is discussed further below on data coding and categorisation.

4.3.0 Data Coding and Categorisation

Coding and categorisation are taken to be inseparable processes in data analysis. For the sake of consistency, only the former term (i.e., coding) shall be used. As Goetz and LeCompte (1984) state, "comparing, contrasting, aggregating and ordering comprise the process by which a [researcher] begins to build a baseline description of the culture under study" (p. 171). The focus in this section is restricted to some key aspects of the process; in particular, locating it within the general framework of the study. The coding was informed by the works of Tesch (1990), Strauss and Corbin (1990) and, Bogdan and Biklen (1998).

categories for coding verbal transactions. Much as the schedules were developed from different perspectives and were specific to particular areas of concern, they were relevant to my work which is eclectic and made contacts with all the areas covered by the schemes. A total of seven interdependent categories were identified. They are: Assignments, Class notes, Modes of representation, Pupil-teacher response patterns, Source of student direction; Source of teacher direction, and Content of teacher's talk. The self-explanatory categories are presented in Appendix 6.

In applying the scheme, codes were given to pieces of data. The data was carved out of the corpus of information such that its integrity was preserved (Tesch, 1990; Goetz and LeCompte, 1984). The data was placed appropriate categories. Each data segment, given an identification code to locate its source, was categorised on the basis of *what topic or activity* (see Bogdan and Biklen, 1998) it entailed. A good example in this case is the categorisation of some questions asked by teachers in class. This involved some validation procedures: the question itself, the response given by pupil(s), and the response from the teacher, mattered. An answer could be at a data level, and further probing by the teacher, clarified the level of thinking the teacher wanted to utilise. It was thus taken to be a communication of intent. For instance, as Ober *et al.* (1971) shows, responses from teachers to answers from class could be classified as: Teacher reacts a) "to maintain level of participation - for example, invitation to continue talking, clarify or summarise ideas at the same or lower level; b) to extend level of participation - for example by requesting further information; c) by terminating level of participation - for example, by indicating that a thought sequence is complete".

However, the coding of data was not without its difficulties. For instance, the data was sometimes a mixture of both "direct quotations" of verbal interactions and, where teaching progressed too steeply or rapidly, recorded observations became descriptive but detailed accounts. These were coded as were others on the basis of *what topic* was entailed. A special category called *condensed lesson* was developed to accommodate those lessons for which lecturing was predominant with relatively little or no variation of pupils activities. The dilemma faced was that of just how much of the classroom context could be omitted without destroying the meaning of interactions (cf. Goetz and LeCompte, 1984). This is how the coding progressed and the key task thereafter was organising the data into a meaningful account of the findings. This is the subject of the next section.

4.4.0 Presentation of Research Findings

The concept of *pattern coding* as explained by Miles and Huberman (1984, 1994) formed the basis of 'writing-up' or rather, of organising the categorised data into a coherent description of findings. Pattern coding, based on the principle of discriminant sampling, seeks to fit data into categories with a better fit such that a more integrated schema (Miles and Huberman, 1994, p. 69) for understanding classroom interactions and other aspects of implementation of curriculum was developed. In view of the inductive nature of the study, the development of the descriptions was intrinsically derived from the data with more focus directed at the actual content of the data. As Tesch (1990) advised, attention was put on "a) commonalties of content, b) uniqueness in content, c) confusion(s) and contradictions in content, and d) missing information" (p. 145) with regard to the topic. Riley (1996, p. 64) is more explicit and states that vigilance should be directed at unveiling the following:

- i) Negative instances which contradicted an idea that is generally true of data;
- ii) Boundary instances that showed limits of the idea;
- iii) Ideal instances that summed up an idea remarkably neatly;
- iv) Oddities, unexpected remarks or behaviours that could not be understood;
- v) Phrases that altered my perception of data, or challenged assumptions about data.

Woods' (1979) criteria for selection of data encompassing validity, typicality, relevance and clarity, was also drawn upon during writing. Miles and Huberman's (1984, pp. 215-249) comprehensive chapter on Drawing and Verifying Conclusions was also consulted. However, the approach has attracted controversy.

For instance, while concern focused on production of accounts adequately supported by empirical evidence, Coffey (1996), Knupfer (1996) and Shaw (1996), for example, show that collection of data, collating it, interpreting and analysing it remains a controversial subject among social scientists. The principle of 'thick description' (Geertz, 1973), in which factors variously impinging on phenomena are explored to give "insight into why people do what they do and persist in doing it", was brought to bear. Patton (1990) endorses the position and states that "validity, meaningfulness, and insight generated from qualitative enquiry have more to do with information-richness of the selected cases and the observational and analytical capabilities of the researcher than with sample size" (p. 185).

On the other hand, Nunan (1996) has observed that analysis from a rich data base might have two key limitations. First, it does not include enough primary data to permit re-analysis. Second, it might also result in interpretive gloss of interactions. Hammersley and Atkinson (1983, p. 174) capture a similar problem which they put down to the influence of *naturalism* with its emphasis

on capturing the social world in description. The problems, clearly inseparable from the research methods adopted, were mainly addressed through direct quotations of evidence or chain-of-evidence such that independent readers could judge the validity of positions presented. Descriptive statistics were also used in situations in which they helped give a clearer view of phenomena.

Nonetheless, this was done sparingly for a number of reasons. The first reason had to do with the broad philosophy and purpose of study, and with how it (i.e., philosophy) informed the conduct of data collection in the field. The observations were open (i.e., unstructured) such that selective focus and variations therein were not suited to reliable quantification of data. Also, it became more and more apparent during fieldwork that some practices were prevalent across schools, which meant that the data collection had to adjust accordingly by being more selective, focused, and by channelling energy to those areas which seemed to be relatively less covered. The moral of the preceding points is that the study had not started with a provision for enumeration of observation. Consequently, frequencies of occurrence from data were restricted to cases in which where it could be done with certainty. For instance, quantifying number of schools, teachers, and books and their use.

The second reason is cogently presented by Goetz and LeCompte (1981) who state that "even if an activity occurred only once, it was significant; relative distribution was unimportant - the objective was categorisation of types of activities" (p. 56). Nonetheless, frequency of occurrence of instances, where used, have been very helpful in the study as it enables one to "to see rapidly what you have in a large slice of data; to verify a hunch or hypothesis; and to keep yourself analytically honest, protecting against bias" (Miles and Huberman, 1984, p. 215). But as Harland and Haynes (1998) argued:

It is important to note that the use of frequencies here makes no pretensions to endow the data with scientifically-rigorous and unproblematic quantification, but aims only to provide a general sense of the greater and lesser amounts of citations received for each of the main categories. One difficulty with collating a numerical presentation for each effect (event) was the system of cross-referencing and multiple coding developed to cater for interview responses containing allusions to more than one category (p. 10).

The above reflects the challenges faced in pattern-matching. However, overall data coding and the subsequent development of the chapter sought to use the data in such a way as to minimise any distortions. Preservation of contexts was enhanced and facilitated by the fact that almost all data had been word-processed and electronically stored in a computer and associated hardware. This ensured rapid access to original source where necessary. The outcome of the data analysis was four chapters: Chapters 5 to 8 of this work.

In reporting the outcomes of the coding exercise and analysis, and hence the findings of research, four key considerations were made. One was that the data presented retained its integrity which was facilitated by the manner in which coding was done as per Tesch's (1990) advice. Each data segment contained a source identification code for cross-checking and ease of reference to the original source where necessary. Direct quotations from interviews, classroom observation schedules and other documents were extensively used. Second, the direct quotations used symbolised recurring patterns in the categorised data while simultaneously illustrating the scheme itself and the nature of events (Edwards and Westgate, 1994, p. 79). Third, the findings of the "study are reported in a context that is 'thick' with description to allow a reader to build and understanding of what has been learned in a way that is anchored in context" (cf. Tobin, 1995, p. 281). Fourthly, the structure of the presentation utilised headings and titles developed through and during the process of analysis. This helped to preserve the integrity of the data, as well as creating a clear link between data analysis and presentation of the research findings.

4.5.0 Summary

While every effort was made to explain the principles and procedures in data analysis, the whole process was reductionist in the sense that the experience and expertise that developed over time could lie beyond the consciousness of the researcher. Sometimes it is just indescribable. However, the mechanics of data coding and the presentation of findings have adequately been captured to provide a background against and a context within which the research findings have to be understood and interpreted. Inherent strengths and weaknesses of the approach are invariably part of the research findings themselves.

CHAPTER 5

GENERAL PEDAGOGIC ASPECTS

This is the first of the four chapters which describes the study's research findings. The main aim of the study is to investigate how teachers in CJSS implement the new integrated science curriculum. One subsidiary question seeks to discover what activities were observed in the classrooms in the use of the curriculum. In focusing on transactions in classrooms as a way of exploring curriculum-in-action, it is imperative to present descriptions of observations of some of the key aspects of the teaching environment. This is the aim of this chapter.

The descriptions and associated evidence were drawn from five areas which are: 1) school and classroom organisation; 2) teacher talk; 3) pupil talk; 4) classroom notes; and 5) assignments. For discussion, the areas are subsumed into four sections viz.; whole class teaching; teacher-pupil interaction patterns; pupil-initiated contributions and, notes, assignments and textbooks as elements integral to science teaching. Data from classroom observations and interviews with teachers is used for developing and illustrating the points raised.

5.1.0 Whole Class Teaching

This section describes the general classroom environment. It attempts to locate teaching in the context of basic education and in the physical and social aspects of schools. The typical class size for five of the eight schools ranged from 40-45 pupils of mixed abilities. In three schools, which opened in 1996, the average class size was 34 - 40 pupils. According to the deputy Head of one school, the location of the school at the fringes of the village brought economic hardships to some parents who could not afford daily bus fares for their children. Consequently, some pupils transferred to schools which were easily accessible on foot. This resulted in not only smaller class sizes but also in relatively low overall school population as well.

Enrolments across CJSS can be characterised as comprising pupils of mixed abilities. The enrolment is exclusively controlled by the government and is not selective as it is based on automatic promotion from primary schools to CJSS. Hence pupils' achievement at Primary School Leaving Examinations (PSLE) is of secondary importance. Also, primary schools and CJSS collectively form the 10 year Basic Education Cycle to which each pupil is entitled. Consequently, the enrolment in CJSS and of individual classes, is of pupils of mixed but very diverse abilities and achievement at PSLE. Streaming pupils to form classes on the basis of PSLE results is not allowed. With each school having two science laboratories, all lessons observed in the study were conducted in science laboratories, the physical environment for teaching.

5.1.1 Physical environment

With the exception of those in a former private school, the laboratories were all built to one design. Their internal dimensions were about 12.5 metres long and 6.6 metres wide. All of them had a set of three porcelain sinks and five gas taps on a hardwood top such that they formed a long continuous workbench running along one length of the laboratory (see Appendix 8). Pupils sat at eight movable basic tables each measuring roughly 2 metres in length, a width and height of about 1.5 metres each. These were arranged in two columns of four tables each, and performed a dual purpose of being a desk for pupils during normal course of teaching as well as serving as workstations during practical work. However, and because of the length of the laboratory, and hence the distance of the furthest table from the board and the teacher, pupils crowded around the four tables at the front of the class. This left almost half of the laboratory unoccupied. This is the context in which whole class teaching occurred.

On the other hand, the position of laboratories in science teaching was rather ironic in the sense that the laboratories appeared to be seen more as venues or facilities for teaching (lecture halls) than as places where various types of hands-on investigations were to take place. As explained later, there were very few practicals observed during fieldwork despite the regular use of laboratories. The seating arrangement in the laboratories themselves give meaning to both whole class teaching and the social aspects of the teaching environment. This is described next.

5.1.2 Social aspects of teaching

Every laboratory had a demonstration table parallel to and about 2 metres from the chalk board. It ran from one side of the laboratory to its centre, effectively dividing the laboratory into two. It separated the teacher's space from the pupils' and teachers conducted their activities from within their defined space. Also any class had fixed groups which were based on pupils' seating positions in class. It was observed that pupils belonged to one specific table throughout a term, and possibly over the year. The table remained their base when doing practicals and taking tests. Nonetheless some teachers sometimes instructed pupils to form their own groups to undertake an activity. For instance, one teacher told the pupils to assemble themselves into groups of 'their liking' to undertake an experiment on photosynthesis. In another case, similar groups were organised for visiting teachers' water closets in a lesson on sewerage disposal. In such cases, pupils were observed to work in their usual fixed groups; possibly suggesting the existence of working relationships developed over time. Two further examples of whole class teaching were of teachers who gave pupils written instructions on the chalk board, then explained them briefly to pupils, and let groups proceed with the activities.

One such case was that in which a teacher asked a class of Form 1s to work together on an exercise which sought pupils' experience and knowledge on traditional First Aid in the home.

The class was subdivided into five groups by the teacher. Each focused on one item from the following list: a) burns and colds; b) wounds and nose bleeding; c) stomach ache and eye injuries, d) snake bites and e) broken bones. The teacher's role during the activity was monitoring progress and rendering advice to individual groups. A member of each group later made a presentation of their findings. A variant of group work, retaining whole class teaching as the dominant form of interaction, is that in which the teacher nominated certain pupils to perform experiments while others were asked to observe. Two pupils per group were chosen to run the heating experiment on Measuring Temperature, while other group members recorded results. There was also a case in which selected pupils single-handedly ran an experiment on Photosynthesis while the rest of the group observed. However, even with stern control over group work, none of the experiments worked: pupils were told what the results should have been. In the latter cases, the organisation expedited progress but with pupils addressed and controlled *en masse*. This was also facilitated by the fact that all groups pursued similar activities at a given time.

However, whole class teaching faced some problems due to mixed abilities of pupils. Pupils' poor performance in experiments is one example. The examination of verbal teacher-pupil interaction patterns gives further insights into the mixed ability teaching environments. The patterns, discussed below, further give in-depth knowledge of the social aspects of the environments.

5.2.0 Teacher-Pupil Interaction Patterns

Teacher-pupil interaction patterns are presented under two subheadings: teacher talk in class and questions teachers posed in class.

5.2.1 Teacher-talk in class

Class teaching was performed in conformity with two predominant practices, namely, lecturing and teacher-driven question and answer sessions. The discussion of how they were conducted and how teachers justified them now follows.

5.2.1.1 Lectures

Lecturing was done mainly during concept introduction and development. This was often preceded by a short question and answer session in which the recollection of facts by pupils was the norm. It should be said here that classroom observations avoided being judgmental about a teacher's question. The answer given by pupils and a teacher's response to it was taken to indicate and underlie its very purpose. Further, the response also showed the level of cerebration required of pupils. A further indication or confirmation of the level is implied in the teacher's response to an answer from a pupil. The classification thus required tracking through the data such that the desired level of cerebration could be identified (cf. Wragg, 1994, p. 28). Appendix 5 contains observation sheets which give understanding of the question and answer sessions which, in some

cases, were the main mode of teaching throughout lessons. More examples which illustrate this mode of teaching are presented in Chapter 6 where the focus is on concept development.

Teachers also lectured widely during class demonstrations in which, and consistent with whole class teaching, all pupils gathered around the teacher's desk. For instance, this was done in demonstrations on Separation Techniques, Photosynthesis and Water Purification. Teachers undertook the demonstrations while making and explaining observations to pupils such that the activities typically took about 10-15 minutes of lesson time. Thereafter pupils would transcribe teacher-made notes on the activity into their note-books. A variety of reasons were supplied to justify the practice. One teacher noting the expediency of lecturing, said:

The thing is, I know that it is not good for the students in the first place. It has never been good in science because the children do not understand very well ... Lecture method, would give us a push by way of covering as much material as possible in a short space of time. We are trying to rush against time. One thing is that we are behind because you do an experiment, they do not understand, and you try to say let them get the message before we go on to the next topic but at the end of the day the person who is examining does not consult the school to see how far they have gone. If we have not covered a good deal of the syllabus our children will not stand a good chance of passing (examinations)...

[Pon, Interview, File 14]

Another teacher used lecturing in handling new topics:

... I use it sometimes when I realise that they may not know anything about the topic ... I just look into what they have been doing and if I discover that they did not cover the topic, that is when I start to lecture but if I spot that thing in their primary school syllabus, that is when I sometimes ask them questions or ask them to do something before the lesson ...

[Kea, Interview, File 5]

One teacher's account as written in my field notes read:

He said he worked based on the syllabus and was conscious of time as the syllabus contains a lot of material which has got to be completed within a short space of time. Therefore, time consuming activities fall by the side, he said. He characterised his teaching as **examination oriented** as the main idea was to prepare the pupils to pass the examinations. Teacher said that though he was aware of advantages of other teaching strategies but he could not use them for reasons already furnished...

[Mar, Field notes, File 4]

Nonetheless, evidence from class observations and interviews showed that lecturing sometimes did not benefit teachers and pupils. Teachers lost in two ways. Firstly on understanding of their pupils' progress and, secondly on the meanings pupils gave to concepts. It was also observed that teachers frequently asked pupils the question "*do you understand ...?*" as a way to finding if

pupils had been following the lecturing. A vignette is provided to illustrate and clarify the points. The lesson was on Ecosystem. It had started at 7:50 a.m. My refined field comments are highlighted in bold lettering.

08:49 Teacher asks: "Are we clear on this?", after introducing and lecturing on the concept of pyramid of numbers.

Pupil: (in vernacular language) "A tau yone a gae jewe ke diboko?" - meaning "Is the lion itself not devoured by maggots?"

Comment: This was asked with reference to the food chain, in which the (seemingly) linear model placed vultures between the lion and maggots. The pupil sought clarification on this possibly because the model conveyed a simplified picture of a real life situation. The teacher translated the question to English and led the discussion of question by way of simple but leading questions. Lecturing resumed thereafter

Teacher: "What is a pyramid of biomass?"

Pupils: (remain silent).

Teacher then explains biomass as "the amount of living matter in an ecosystem". This is all the teacher said before asking the question once more:

"What then is the pyramid of biomass?"

Comment: Teacher embarked on direct questioning with minimal concept development. This appeared to reflect his expectations based on the reading exercise he gave the students in advance of this lesson.

Teacher: "Yes, Rebaone, give an answer to my question!"

Rebaone remained silent.

Teacher: "Come on think. You can't tell me you do not know the answer. Emmanuel, Kedibonye ... say something!"

08:56 Faced with difficult situation, the teacher attempts a demonstration on the board. The example is not working either and teacher acknowledges this:

"Our example is not going to give us the right thing!"

Comment: Teacher was unprepared for this as he anticipated smooth sailing assuming pupils would have done their reading assignment. He had checked if they had read at the beginning of the lesson. Faced with the low performance of pupils, the teacher lectured revisiting the concepts of food chain, food pyramid, biomass, and pyramid of biomass, in that order. This was terminated with a question:

"Are you clear about that?"

Pupils: "No!"

Teacher: "Are you clear about that? Do you understand pyramid of mass? Did you get it? Did you get it ?" (repeated and shouted at pupils)

Pupils (unshaken and maintaining their resolve): "No, teacher!"

The teacher now with bit of temperament and annoyance retraces his story, struggling to distinguish between pyramid of numbers and biomass. When finished, the teacher asked:

"Do you have any problems?"

Pupils: "No, teacher!"

Comment: The pupils' answer was tactical in as much as the teacher's question was. Reading his mood, and probably from experience, pupils knew that answering in the affirmative would have saddled them with the burden of articulating their problems. And, for the teacher, it was a way of passing the ball into the pupils' court - not that he expected much from them, but as a divide and rule strategy. This is the message pupils in many other classes elsewhere seemed to know well.

09:02 Teacher (looking relieved): "OK! Imagine you have a small pond . You have small organisms in there - frogs, *dikoduntwane* (tadpoles). Now let us talk about the food web of the pond. What other animals are there?"

[Rak, Observation sheet , File 7]

Apparently, pupil response legitimised the teacher's move to the next phase of the lesson. My explanation that pupils' knew that saying they did not understand meant pin-pointing the area of difficulty was corroborated by one teacher who said that answering *no* would normally and instantly give that pupil the responsibility of explaining what it was s/he did not understand. As a consequence, some pupils simply answered "yes" to appease the teacher and to save themselves trouble. However, some teachers said it was difficult to monitor understanding of pupils during the course of teaching. One said:

.. the only way to see if they have understood is to give them an exercise, normally class work. That is when you can see that the person does not understand. Even then, you still do not know exactly how that person does not understand because you just look at the mistakes the person has made and think of what might be the problem. It is really hard for us to diagnose and recognise the problems that they might be having.

[Mok, Interview, File 10]

Another said:

Though I tried to involve them, there are some pupils who are listening but they do not understand ... there are some people who were not involved ... they are left behind and they do not even know what we are talking about...

[Bai, Interview, File 11]

This was corroborated by evidence from classroom observations which showed that lecturing was done across all classes, irrespective of pupils' year of study and abilities. Teachers' coverage of the whole syllabus is mandatory by virtue of each year having a prescribed content. Also teachers invariably felt pressured and obliged to cover all curriculum content for examination purposes.

Generally, concern with examinations also implied concern with time. The issue is explored later in Chapter 8.

5.2.1.2 Teachers' questions in class

Another predominant feature of science teaching was extensive question-answer sessions which were always undertaken at the beginning of every teaching session. Two key observations made were that teachers generally asked questions which required pupils to recall and supply factual answers, which were an end in themselves (refer to Table 5.1). On the other hand, teachers were predisposed to searching for answers framed within their (i.e., teachers') framework of knowledge of science, rather, science-based. Consequently, a failure to see phenomena from pupils' perspective was prevalent. This issue will be revisited in several ways in this and in the next chapter. Illustrations of the two aspects are provided below.

The most striking feature of the classroom transactions is that while pupils supplied correct answers most of the time, the purpose of asking the questions was unclear. What was also unclear was how the questions and answers were meant to develop and expand the pupils' knowledge repertoire. In short, it was unclear how the questions fitted in with concept development. This is shown, for instance, by the following transaction drawn from an introduction in a lesson on rock types:

Teacher: What is weathering?
 Pupil: Weathering is the breaking of rocks.
 Teacher : Then what is erosion?
 Pupil: The removal of topsoil from one place to another.

[Mol, Observation, File 3]

The teacher accepted the two definitions without paying due regard to the limited view of both concepts as held by the pupils. There was also disregard for the multifarious ways in which weathering could be manifest in nature. This prevalent mode of interaction seemed to be a consequence of reading assignments which pupils were given as preparation for a next lesson. This is discussed fully later in this chapter. Nonetheless, pupils did not always give correct answers. In one situation in which the questions prompted pupils to rely on memory, the introductory words to a lesson ran:

Today we are going to dissolve something in water. What were you taught is the name given to water?

[Moe, Observation , File 3]

Pupils (Form 2) failed to recall the term despite the teacher listing items which could dissolve in water in a bid to aid pupils' memory. "Solvent" was the answer required. Yet another teacher said:

What did you get when you did the experiment? (pupils remained silent) ... You should always make sure you remember the experiments! OK! What did you use in the experiments?

[Tho, Observation, File 5]

Pupils remained silent regardless of the hints and prompts supplied by the teacher. In one case, pupils in two different classes, one on Measuring Force and the other on Density, could not state that a Triple Beam Balance was an instrument for measuring mass:

Teacher: What instrument do you use for measuring mass?

Pupils (speculated): scale, force-meter, measuring cylinder ...

[Mau, Observation, File 13]

Some shrugged shoulders before one pupil said a *triple beam balance*. The very same question proved to be difficult to a Form 1 class within a month of taking a module on measurements. In the latter incident, involving the same teacher, pupils gave wild answers: "Cork ... scale ... ruler, triple beam balance". The pupils also could not state the largest mass the instrument measured. From the observation, it was difficult to infer with certainty whether the teaching methods, the teacher, or the pupils, were culpable for this apparent low performance. However, it was noted that teachers still showed great reliance on asking questions as a teaching strategy, albeit with no variation in case of difficulties.

The second observation that teachers were predisposed to see pupils' contribution from their (i.e., teachers') position is demonstrated by the following two examples. In one case, the following transaction occurred:

Teacher: What do we mean by paralysed?

Pupil A: It means a person cannot see.

[The teacher ignored the response.]

Pupil B: It means not being able to move ...

[The response is ignored by teacher.]

Teacher: Have your ever seen people in wheel chairs? It is because of paralysis. They cannot move.

[Ram, Observation, File 9]

A similar observation was made in a lesson on Sewage Disposal:

Teacher: Why is it that solids fell to the bottom of the septic tank?

Pupil 1: ... because they are heavy.

[Teacher ignored this, re-directs the question to another pupil]

Pupil 2: (remained silent)

Teacher: They are denser than water.

[Mas, Observation, File 9]

The dilemma created by the above, apart from ignoring what was possibly a plausible answer, is that not all solids in the septic tank pupils had visited earlier had fallen to the bottom. This basically questioned the validity of the teacher's question, in particular, what 'solid waste' referred to. The following transaction had occurred earlier:

Teacher: Why does the pit latrine have to be 3 metres deep?

Pupil 3: So that it does not get filled easily.

[The response is ignored by teacher. Another pupil is nominated to answer]

Pupil 4: (reading from textbook) So that mosquitoes and flies do not breed in it.

Teacher: (acknowledged response and asked) What is wrong with flies and mosquitoes breeding in a pit latrine?

[No response was obtained from pupils and teaching resumed.]

[Mas, Observation, File 9]

Many similar incidents reflecting teachers' interests in correct answers will be found in various parts of this work. The reasons that teachers gave to explain their practice varied. They ranged from undertaking questioning as a selective activity down to the benefits the practice guaranteed teachers. As a selective activity, some teachers distributed questions to targeted pupils based on in-depth knowledge of their abilities and capabilities. One such teacher explained:

If I had to ask a question, I know the pupils who are going to answer it and I do anticipate a response from them. Then, at one point I make sure that questions are stretching, reaching even those who understand fast, then some of the questions should also suit those who are of low ability.

[Mau, Interview, File 13]

Classroom environments and interactions could thus be specially contrived and manipulated by teachers to reach some desired goals which might be of lesser benefit to pupils. Nonetheless, another teacher acknowledged that some of his questions were of limited currency in learning:

Like we said earlier on, the lesson was more teacher dominated than pupils dominated. ... Pupils only had to answer questions from the teacher. The lesson as it was actually did not allow for more participation from the students except answering questions here and there.

[Rak, Interview, File 1]

The purposes of questioning were rather limited in scope, the commonest one being that of relating old to the new concepts:

I am relating previous knowledge to ... I am continuing on something we did. It is not a completely new topic. They had done Cell and Reproduction ... so when I ask the questions, it is to help them to recall what they have learnt before and to get them involved in seeing the trend.

[Dus, Interview, File 6]

Along the same line of thinking, an account in the field notes states:

She found the previous knowledge useful in teaching in the sense that it is easier to drive to the new topic - moving from the known to the unknown. For that she used question and answer technique quite extensively. She said participation of pupils this time round gave her the impression that they had understood. She also used the questions primarily for purposes of making the students see the direction in which she is driving them.

[Gar, Interview account, File 10]

The teacher whose lesson was (cited above) on Waste Disposal explained the utility of questions in teaching in terms of encouraging active participation of pupils in class. He said:

Actually, most of the students want to be err, err ... passive learners and they expect a teacher to be always telling them. Some of them do not get it at all and through questioning - I think it is the only way to involve the pupils in teaching. ... like others will simply be seated there thinking of other things and if most of the time you are questioning they are always awake ... We are supposed to pick all of them but the class that you observed is full of the slow learners, full of Ds with a few bright ones. ... it is the attitude of the teachers. Most of the time they centre on those who are sort of bright, if I may say ...

[Mas, Interview, File 13]

My observations of classes confirmed that pupils' participation was high, if construed in the sense of their answering questions from the teacher. However, the place of question and answer sessions in teaching was not well-defined. While the practice might have been worthwhile in content coverage, little seemed to be known of the intellectual returns it afforded pupils:

... I may say that some did understand but not all of them understood ... but through questions or questioning I could say most of them really grabbed a lot of what was being taught ...

[Mok, Interview, File 10]

But,

... when I ask them those questions which require a lot of thinking and not just short answer type, they tend to get lost may be because of the language, that is why I tend to ask short-answer questions. .. After I have discovered that ... they might have grasped something, that is when I introduce those divergent ones or situational questions .. but when I start up the topic, I come up with those short-answer questions such that they do not get lost as I keep them on the track.

[Kea, Interview, File 5]

However, as it transpired from interviews, the importance of pupils 'remembering' or 'recalling' rather than showing understanding of concepts was valued; being 'forgetful' was found undesirable. As one teacher said, relating questioning to the spiral nature of the syllabus:

The main problem is that it tends to be a bit difficult as we have to revisit sometimes what we did in the first year because the pupils tend to forget even what we did in the past two weeks very easily ... the problem is that these kids 'learn to forget' so when you teach the topic in another year it means you have to spend about 20 to 30 minutes revisiting what you did in the first year so that they can have a clear picture that the(se) two topics are related otherwise they will take it as a topic on its own ... I ask them questions then they answer back with the hope those pupils who had forgotten completely will now remember what we did in the first year.

[Pon, Interview, File 6]

Following from concerns with learner forgetfulness, some schools had action plans to help pupils retain science knowledge. In one school remedial lessons were being planned. In another, teachers had resolved to give pupils regular but frequent tests covering a wide range of topics. It was said the latter strategy had been tried and adopted with success by mathematics teachers. On the question of why emphasis was to be placed on remembering, all teachers felt that it was necessitated by the nature of the syllabus, which can be referred to as *spiral* (see Chapter 7).

In summary, Table 5.1 below shows the distribution of acceptance/rejection of pupils' responses by their teachers. The predominance of Cases 1, 2, 3, 6 and 7 generally indicate or corroborate teachers' views that pupils' participation in class were enhanced by questioning. On the other hand, low entries in Cases 4 and 5 were related to the relatively high count of Cases 6 and 7. The answers which pupils gave were mostly at the level of recall and were an end in themselves. Also, in reading teachers' views on questioning, it is clear that questions were asked for a wide range of reasons other than those directly related to involving learners in conceptual development.

On reflection, the fact that pupils were said to be forgetful could be taken to indicate a consequence of two interrelated pedagogical issues. One is that extensive lecturing, and variants thereof, was very likely to have been incompatible with the modes of learning appropriate to pupils. There was also a possible lack of understanding of the demands of the curriculum, in particular, of how to build conceptual development. Encouraging recall of concepts learned previously appears to have been widely construed as vital for teaching purposes, in particular, in concept introduction. It could be suggested that question and answer sessions had a psychological impact on the learners in that lessons began with information retrieval, thereby possibly placing pupils under pressure to memorise material in advance of a lesson. Clearly, while teaching was characterised by teachers as mixed ability, it seemed to be so only in principle, not in practice.

Case	Teacher's Response	Frequency
1.	Rejects a pupil's answer and gives his/her own response	19
2.	Rejects a pupil's answer outright	17
3.	Ignores a pupil's answer	14
4.	Reacts to maintain cognitive level of participation e.g. invites pupils to clarify or give information at the same or lower level	5
5.	Reacts by extending cognitive level of participation - e.g. requesting further information	2
6.	Accepts a pupil's response at first attempt	Ubiquitous
7.	Reacts by terminating level of participation - e.g. asking new but unrelated questions or starts some new activity	ubiquitous.

Table 5.1: Teacher Acceptance/Rejection of Pupil's Answers

Notes:

- a) The above relates to data collected from Phase 1 of the study only. The mode of recording allowed for the above analysis to be made from the field notes. However, no changes in practice were identified in the course of field work.;
- b) *Ubiquitous* above means that the incidents were too frequent to count.

The next section explores pupils' contribution to learning. This is a way of seeing the teaching environment from a different perspective and this creates a fuller understanding of the classrooms.

5.3.0 Pupils' Contribution to Science Learning

Pupils sometimes contributed to science learning through asking questions. This constituted evidence that pupils were not passive recipients of information even though teachers dominated science lessons. The relatively few instances in which pupils asked questions revealed that the questions were intelligent and relevant to the topic at hand. The very fact that some pupils asked such questions provided a favourable picture of their abilities. The other point demonstrated is that pupils expressed themselves either in English or in Setswana. The choice of language seemed to depend on which of the two afforded pupils clarity of expression and self-confidence. Another theme which comes across clearly in the examples is that pupils mostly tried to infuse into and relate to science concepts their own everyday experiences. In all cases, however, teachers were predisposed to play the role of expert and hardly presented the questions to class for wider debate. The latter observation, and the other themes raised here are illustrated below with examples drawn from various classroom contexts.

In one lesson on Diseases of the Circulatory System, a pupil asked: "*What is the difference between fat and oil? Is there anything like vegetable oil?*" The teacher's response was that "*Fat is solid at room temperature while oil is in a liquid state!*" Another pupil in the same school but in a different class enquired about causes of deafness. She told the class that her grandmother used a hearing aid. The teacher gave no direct answer. He said there could be many causes and, without developing his response further, started lecturing on hearing aids. In one instance, a pupil asked a question probably prompted by some form of cognitive conflict arising out of trying to reconcile her knowledge of 'ginger beer' and teacher's presentation. The pupil asked if ginger is an alcoholic beverage. The pupil's question seemed to have been prompted by the fact that ginger actually ferments into an alcoholic beverage if conditions are right. Furthermore, it serves a dual purpose of being a soft drink and an alcoholic beverage (when fermented) in social ceremonies in Botswana - weddings in particular. There is also Ginger Beer which is marketed commercially as soft drink and is widely available in retail shops. The teacher's response was that Ginger is a soft drink. No justification was given. The pupil was then asked: "*Are you answered?*" and she replied : "*Yes*".

Illustrations like the above raise questions as to what image of science the teachers were giving to the pupils. Science learning seemed to be asocial and esoteric as pupils were isolated from formulation and/or supply of answers to questions from colleagues. Also, teachers did not tease out the meanings of questions from pupils but were always ready to act as though questions were clear to all in class. In addition, teachers tended to give answers which seemed to be facts or truth(s). The issue is revisited in Chapters 6 and 7. However, not all questions were answered by teachers. In one case a pupil enquired:

How do fruits in a shop exclude microbes? I have seen them (fruits) lying on shelves but without getting bad.

[Moi, Observation, File 12]

The teacher could not explain this, and had difficulty formulating a response. In another case, a teacher explained the operation of an eye lens using a glass bi-convex lens. One pupil asked how people come to know the proper orientation of an object since the lens inverts it. The pupil enquired further:

If the person is upside down, what do we expect to get? How come he is not seen to be upright?

[Pon, Observation, File 14]

The teacher had difficulty in explaining this.

Questions framed in Setswana were both sensible and valid as was the case of a pupil who enquired if plants photosynthesised on a cloudy day. The teacher down-played the essence of the question as the pupil was made to look stupid; that, if she could see on a cloudy day, implying that there was some sunlight, what then suggested to her that plants could not photosynthesise, was the response. In another incident pupils attempted in English to debate the question on Food Requirements by males and females. Pupils displayed a general understanding of the theme but the points they raised were based on observations and experience though they failed to articulate them easily. The teacher allowed presentations and the general debate to be done in Setswana. This implied that teachers and pupils could be flexible in language use in teaching particularly that almost all teachers shared the same language with pupils. But the opportunity was hardly explored as communication was usually in English.

Teachers generally performed rather weakly across a total of at least 17 experience-based questions pupils raised. The extent to which teachers often failed to rise to the occasion raised questions about both their mastery of subject content and pedagogical approach. On the question of language and science teaching, it was apparent that English and Setswana existed side by side as modes of self-expression though pupils seemed more predisposed to speak in the latter (mother tongue for majority) when they asked questions. This possibly had implications for science teaching. But as has been shown, pupils raised valid questions which suggested that some were not mentally passive during the course of teaching, and actually made some sense of concepts presented in a language other than their own. The next section looks at the positions of notes, assignments and textbooks in science teaching.

5.4.0 Notes, Assignments and Textbooks

Teacher-made notes, pupils' assignments and textbooks were integral to curriculum implementation. The form and shape of each of the activities is discussed below as is their respective position in the implementation of the curriculum.

5.4.1 Teacher-made notes

Teacher-made notes, transcribed by pupils from chalk boards into their note-books had become an intrinsic characteristic of almost every lesson observed. The notes were characteristically coherent, elaborate and written in simple English. What also became apparent was pupils' commitment to the task of copying. Pupils did not query, for instance, legibility of handwriting; clarity of expression; or, the amount of material covered, which sometimes appeared excessive. Pupils' notes were not checked by teachers either during or after they were done. The latter observation seemed to suggest that the place of notes in the curriculum was perhaps self-evident and established. Table 5.2 is an overview of variations that were observed in the conduct of the activity.

Form of activity	Frequency
Teacher writes notes, pupils transcribed them simultaneously	35
Introduction of new material through notes	10
Pupils instructed to leave spaces for diagrams in notes	7
Pupils write no notes during lesson	4
Pupils are to continue writing notes after school	8
Continuation of notes started in previous lessons	4
Teacher writes notes, pupils idle	2

Table 5.2: Nature and Conduct of Notes

Writing notes, which commonly ran for 10 to 20 minutes at a time, usually followed lecturing on an aspect of a given topic. However, not all teachers alternated lecturing with note-taking. In nine instances, the notes were taken as an isolated activity done in the last 15 - 20 minutes, or in other cases in five minutes of the teaching session. The reasons for this were two-fold. There were instances in which this was done so that the activity could continue during the afternoon pupil preparatory time. Where this occurred, one trustworthy pupil with a 'good' handwriting would be delegated to write the notes on the board for other pupils to copy, as the teacher would not be in attendance. This strategy in effect meant that teachers proceeded with planned teaching activities during normal class time and pupils' study time served as an extension of the lesson. One such teacher stated this cogently:

I normally give them the notes when we are through with a particular topic like First Aid. ... If I can teach and may be give the notes at the same time, may be in that particular lesson, I will cover little content therefore I have to teach what I have planned for in that lesson and then when I think I have covered enough, or even more, I can then give notes ... the thing is, when I plan for a lesson, I plan for what I will be teaching ... if we do an experiment, we won't be able to finish the experiment because of taking notes.

[Obo, Interview, File 1]

There were at least four instances in which different teachers in separate schools devoted whole lessons (i.e., 80 minutes) to writing notes. One case was of a teacher whose notes on the Heart and the Circulatory System were elaborate and complete with two diagrams, one of the mammalian heart and the other was a simplified human blood circulatory system. Pupils complained of fatigue when the session ended. Another teacher used an Overhead Projector to give notes he had developed on Reproduction in Plants. In such cases, it would seem that notes were given as a record of what transpired in lesson and as what pupils ought to know. Teachers' views and predisposition to the activity, however, were wide-ranging. These are discussed

starting with a brief focus on how teachers attached value to the notes and communicated this to pupils.

Classroom observations showed that pupils were made to value the notes in various ways. In one case, Form 3 pupils were made to recite a table of Compounds and Elements which was on the board and which they then copied into note books. Pupils were instructed:

Make sure you know your notes thoroughly, you are a beginner here. If you don't read, you will forget! ... Make sure you copy the notes correctly, otherwise you are going to learn wrong things from the note book ...

[Tho, Observation, File 5]

A similar activity was noted in another school with Form 1s, who were in their second week of orientation after transferring from primary school to CJSS. This probably amounted to initiating pupils into a culture of learning they were likely to follow for as long as they were taught by the teacher. Further evidence of the teacher as a factor in promoting the importance of notes in science teaching is available. In some cases, teachers rebuked pupils who could not provide answers to recall-based questions. The 'offending' pupils were typically asked if they had not read their science notes. Moreover, class reviews, where linking the old and the new concepts was vital, generally followed the logical sequence and structuring of the teacher-made notes. Also, teachers did not encourage pupils to make their own notes. Although, the available textbooks did not cover all the areas of the curriculum, pupils appeared to be made to see notes as *the textbook*. With this sort of routine, it was not surprising when one teacher, who had been observed teaching a Form 3 class said:

Without notes, performance nose dives; with notes, even the poor ones excel ...

[Gar, informal discussion, File 10]

However, a possible close correlation between the notes and the test items could account for the alleged level of improvement in pupils' performance. Also, while the teacher's view was echoed by others, an independent confirmation of the pattern has not been made. There were, nonetheless, teachers who had become sceptical and wary of pupils' over-dependence on notes. One said:

Even if you have a group where you explain everything and where you think there is no need for notes, you would realise that they do not read the textbook but would read the notes you are giving them - because they believe that the tests are set from the notes. So sometimes you find that the notes are a duplication of the textbooks - not necessarily that I want to duplicate it ...

[Pon, Interview, File 6]

Another theme which emerged in interviews was that notes addressed two fundamental constraints viz.; lack of proper textbooks designed for the curriculum and, the abilities of pupils.

As reported in one interview:

The reason why I gave them notes ... is because we do not have textbook that is relevant to the 3 year JC syllabus so most of the information or notes are from different sources. So I compile notes from different sources. If we had a particular recommended text, I feel we would give them very little ...

[Mas, Interview, File 13]

And, another teacher explained how notes are used to confront problems in teaching arising from diverse ability of pupils:

Q: You have hinted at the existence of language problems amongst learners and which you see as a hindrance to their learning of science ... How were they, if any, manifest and how did you handle the situation?

A: It ends up making me somebody not really teaching but writing. But again I just have to do this because I have to pass some information on with a clear understanding that most of the time they do not understand anything that I am saying and they tend to lose interest ... I used to describe it as a mosaic situation in which if you look at the eyes of an insect it sees a picture in a mosaic and if you imagine that should you blind a few of the eye units, it will see some part of the picture but in the end it does not get a clear picture ... When they read they understand certain words 'and', 'it', 'the' ... and things like that but when it comes to science words, they draw a blank. So at the end you deliver no picture. If you write it, you still have done nothing. You give them the book, you still have done nothing. So that thing is there.

[Dus, Interview, File 6]

Earlier, I visited a group of four boys seated at their table at the back of the class. I noticed they copied notes from each other. The following mistakes were common to the group: the word "*freapitation*" had been written in place of "*precipitation*"; "*coatially*" for "*continually*" and, "*rainball*" for "*rainfall*". This corroborated the views expressed above by their teacher. What could not be established was whether the pupils were slow learners and what their seating position suggested. The latter group's mistakes conjured images of note-taking as akin to a mechanical routine to which pupils gave little thought. But as has been noted, teachers never supervised the activity in my presence and any mistakes remained uncorrected.

Two further recurrent patterns concerned note-taking and seemed to indicate that the activity may not have benefited pupils. One was that the notes were devoid of pupils' everyday experiences, or rather, failed to link concept development to pupils own real-life situations. This phenomenon is shown in the instance of a teacher who, on teaching a module on Measuring Force to 15 year old pupils, gave highly technical and lengthy notes pitched at a level way beyond that of the pupils and the syllabus. The high level Physics in the notes was not only difficult, but also illustrated the

vast intellectual difference between the teacher and his pupils. The examples were from a foreign context as they related tidal motion to various phases of the moon and the associated gravitational pull. The teacher's observation that no fisherman would go to sea at full moon most probably meant little to the pupils whose village was on the periphery of the Kgalagadi Desert in a landlocked country. The village, sited on a largely rocky terrain, relied exclusively on an underground water supply. The pupils diligently transcribed the notes and associated diagrams into their note-books. In another case, examples of ways to avoid damage due to expansion and contraction were drawn from a science textbook and incorporated into the teacher-made notes.

The other theme related to teachers for whom notes provided an opportunity to make up for their apparently low subject matter content knowledge. One case in point is that in which teaching Atomic Structure appeared challenging to one teacher. The presentation was done in roughly 15 minutes after which the teacher started writing notes on concepts not covered in teaching. The notes were text copied verbatim from Chalebgwa *et al.* textbook, page 55. In yet another incident, a teacher had difficulties with 'the carbon cycle' and directed pupils to read from page 180 of the textbook, *Science by Investigation in Botswana: Pupils Book 2*. Towards the end of the lesson pupils were told to copy from the textbook the three paragraphs on the carbon cycle into their note books. In one case, pupils in one school were given notes devoid of substantive science concepts. The notes read:

A balanced diet contains enough of each of different food types. Balanced diets are not the same for all people. It depends on age, sex, and occupation

[Yeo, Observation, File 11]

No elaboration was made. It was cases like these which challenged any views one might have had about the purposes notes were meant to serve. Overall, however, teacher-made notes were multi-functional though they seemed not to be clearly directed at developing pupils or at satisfying the remit of the official curriculum. If the notes did, then, it was not clear how. What is apparent, though, is that the notes seemed to address various concerns teachers had identified as bottlenecks in the implementation of the science curriculum.

5.4.2 Assignments

In general, the assignments could be placed into two categories: writing and reading. Written assignments had two sub-categories: answering end of chapter questions and copying diagrams from textbooks into notebooks. Reading assignments all required pupils to read a specified text in advance of and in preparation for a lesson. Each group of assignments is treated separately.

The typical characteristic of questions in written assignments was that they were mainly at a level of recall or, alternatively, required pupils to elicit answers directly from some accessible source of information such as a textbook. Assignments were almost always revised in class and

not submitted for marking, perhaps corroborating the view that answers were derived from some accessible source and were not pupils' own. In the revisions, individual pupils tended to answer a question as and when they felt ready and confident. A poor performance or lack of interest in a question often suggested a difficulty which teachers were quick to solve. Another observation regarding the written assignments was the short deadlines, typically 24 hours of the lesson in which they were issued. Whether the arrangement was meant to summarise or to reinforce concepts from the lesson was not clear, particularly as answers were possibly from some readily accessible source.

As was the case with teacher-made notes, pupils appeared to accept the tasks without query. In only one case did the pupils overtly express their resentment of a short deadline. They vented in Setswana their resistance:

... nna ke nna kgakala ¹... nna ke ka sekgone, kana some other teachers give us tasks as well²; Rona re a practising³ .. Nna Art teacher⁴ ...

[Translation: ... I stay far away¹ from school ... I cannot manage because other teachers give us tasks as well²; we are going for a practice³ and therefore the deadline is unrealistic; For me the Art teacher⁴ ..]

[Moi, Observation, File 12]

Nonetheless, despite the protests the class monitor was instructed to collect the assignment by 3:30 p.m. The general observation that the assignments were rarely collected for marking, or checked for completion, suggests that pupils in some cases might have not taken them seriously. A similar observation could be made of six other instances in which pupils were asked to copy specified diagrams in textbooks in preparation for the next lesson. In addition, the purpose of the drawings was elusive. For instance, the case of pupils who drew a mammalian heart which, though not all pupils had drawn (teacher inspected their work), was not used in the lesson on "Blood and The Circulatory System". It appears that the diagram was drawn for its assumed intrinsic value to understanding the topic. Upon finishing the topic, the teacher proceeded to a topic on Food Production in plants. This was not peculiar to one teacher as testified by the following explanations:

I knew I could either draw the diagram on the chart and discuss it with them but I found that my time, with other things in mind, could not allow me to draw the chart ... But I felt they should have it in their note books so that when I discuss it, they are able to say he is talking about the mouth ...

[Pon, Interview, File 14]

The accuracy with which diagrams were reproduced was assumed. As one teacher explained:

I ask them to try and label some diagrams in advance for the topic which we will deal with in the next class. And then ... in that area I don't encounter any problems and I don't ask any questions relating to that.

[Mru, Interview, File 7]

In contrast to the above practice, a total of at least 12 reading assignments were taken rather seriously by teachers. It also seemed that the length of assignments closely correlated with and reflected how much material the teacher wished to cover in the following lesson. One example is that in which pupils were assigned to read overnight about carbon dioxide, its preparation, properties, and uses. On the next day, selected pupils made presentations. One pupil presented on carbon dioxide (what it is); another on its preparation; the third pupil focused on its uses; and, two others, on its testing. Their presentations received little attention as they were made with confidence and with a high level of accuracy. The paradox here is that there appeared to prevail a view that assignments made pupils learn information independently. One teacher said:

... it has been some kind of beneficial to the students ... Because their participation in the discussion showed that they really got something from the reading assignment ... By discussion, I mean sharing ideas like I said, I gave them a reading assignment. I wanted to get some ideas from them regarding how they understood the topic, what they knew from what they read!

[Rak, Interview, File 1]

Pupils were also seen to shoulder a high responsibility for their learning:

I feel, actually the whole of the teacher's job ... constitutes 10% while that of the student goes to 90%. So for that 90%, if he is little familiar with that topic which he is going to learn, then the hunger, the initiative is going to come from them.

[Mru, Interview, File 1]

While another realised that not all pupils read:

Normally, those who take the initiative to read, they first of all see some things they may not understand. Then when it comes to class and discussing them, they start to remember and that serves as a repetition to them because they have read about it and can ask questions where they do not understand and it is clarified to them. When they go back to read again, they know exactly what to look for.

[Koo, Interview, File 14]

However, my empirical evidence did not support claims that reading and written assignments were of benefit to pupils since they repeated the text. One teacher corroborated my observation:

Yeah , most of them will take everything from the passage though the answers will be correct. For instance, this week I gave Form 2s an exercise to read about distillation and answer questions I had not covered in the topic ... they could not really write the answers that were more sensible because they wanted to take the text as it is ... they cannot read and apply what is written for them.

[Pon, Interview, File 6]

Another teacher said:

.. most of them cannot understand or even read English. It is a problem of how they are taught a primary level! They cannot even construct a sentence in English nor write one ... some of them are so disadvantaged that they do not actually benefit a thing! ... The extreme ones I should admit, they are unfortunate.

[Rak, Interview, File 1]

On the other hand, and placing further doubt on the merits of the reading assignment and discounting some views expressed above, is the observation that pupils did not seem to effectively use information from reading assignments in learning:

We have a problem in this school because most of them never ask questions even when given encouragement to. They sort of are always 'dull' like that - they never ask questions. ... It is very difficult because the only way to see if they have understood is to give them an exercise, ... That is when you can see that the person does not understand . Even then, you still do not know exactly how that person does not understand because you just look at the mistakes the person has made and think of what might be the problem. It is really hard for us to diagnose and recognise the problems that they might be having.

[Mas, Interview, File 13]

On the issue of diagnosing and realising the problems, it appears that reading assignments contributed to the problem to some extent in that pupils' responses to questions were almost always high. This meant that one could not tell if learners had any problems beyond those which were obvious in presentations. One other observation, further suggesting that intellectual returns accruing to learners were questionable, was that teachers did not expand the pupils' horizons beyond what they had read. For example, one pupil said that "carbon-dioxide is an oxide of carbon", which statement was taken by the teacher as it was and later incorporated unmodified into the notes on the board. It could also be that teachers did not know how to make reading assignments part of their lessons.

There were, however, incidents in which knowledge from reading assignments derailed planned concept development. The following transaction is incisive:-

Teacher: OK, can we settle down and talk about the flower ... what is the use of the flowers, why do flowers have petals?

Pupil A: ... they need petals to attract insects.

Teacher: Do all plants have petals?

Pupils (en masse): No!.

Teacher: How can you explain that?

Pupil B: ... there is self-pollination and not cross-pollination!

Teacher: Phew! you are touching on new terms that we haven't covered. Let us shelve that for the time being , ... Now, what colour are the petals?

Pupil C: ... brightly coloured to attract insects.

[Mar, Observation, File 4]

The pupil had gotten her response from the textbook and, together with teacher and pupils she did not realise that the flowers that they had brought into the laboratory had yellow petals. Teaching proceeded with the teacher persistently complaining that the pupils were always steps ahead - outsmarting him in the process. This is one case in which a teacher admitted some difficulties posed by reading since pupils embarrassingly volunteered more information than was needed for a particular question. On the contrary, in cases where pupils were careful with their knowledge the lessons progressed smoothly though with limited or no expansion by teachers on memorised information supplied by pupils.

With particular reference to reading assignments, the characterisation of a class as comprising pupils of mixed abilities appears to get support from teachers' explanations of their practice. Two contradictory images of the learner were apparent teachers' explanations. On one hand, there are pupils who were characterised as initiative-taking, anxious to learn, and making good use of reading assignments. On the other hand and towards the extreme end of the continuum of pupil abilities, was the *problem-child*: unimaginative, near-dyslexic, and possibly, 'mentally retarded'. However, the problem child was at the epicentre of teachers' justification of their practice, though the noted predominance and prevalence of lecturing and questioning appeared to reveal a general neglect of him/her.

There is generally insufficient evidence to conclusively state whether the assignments engaged all pupils intellectually. What has been noted, however, are several consequences of the reading tasks. Overall, pupils memorised as much information as possible as questions asked in future lessons required. Pupils appeared to be seen as sources of knowledge to be tapped during teaching. However, in the light of pupils' widespread problems in English, pupils' regurgitation of knowledge from texts was seemingly viewed with ambivalence by teachers as it was not interpreted as understanding. One consequence of reading assignments was that some of the strengths and weaknesses of learners were not identified, addressed or explored in lessons. This leads to discussion on the use of textbooks in teaching.

5.4.3 Textbooks

Various textbooks were used in science classrooms. Appendix 10 contains descriptions and positions of the texts in the implementation of the science curriculum, previous and current. Despite the fact that none of the textbooks was specifically developed for the curriculum, teachers used them widely. As has been revealed in the previous sections, various science activities were drawn widely from various textbooks. The textbooks fell into three groups namely, texts written for previous curriculum innovations in Botswana; for the current curriculum and lastly, for science curricula in European countries. In the sections below, the focus is briefly on teachers' use of and views about the text books.

Since the textbooks, Book 1 and 2 of *Science by Investigation in Botswana* were developed as part of package for the two-year science curriculum, their influence in teaching was noticeable in the teacher selection of isolated but appropriate sections for a particular topic. One teacher said:

We are still using the old ones for the old syllabus. Sometimes you find Form 1s using Book 2 ... the syllabus is developed around this spiral approach - so that is the problem: we do not have a good book to use. These 2 year J.C. texts - they do not have all the materials we need ... so the syllabus is a bit advanced compared to the 2 year J.C. one.

(Bai, Interview, File 11)

This sometimes led to incoherent and shallow presentation of topics as teachers did not expand on the text. Another teacher said:

A few topics may be found in them but do not meet all the requirements or the objectives of the syllabus hence we have to be running around looking for texts with information ... If I may give an example of a situation which is going to arise, the section on computers, there is nothing on that section in the textbooks, there is nothing on communications ...

(Mas, Interview, File 13)

However, a workshop on teaching the said section was hosted in February 1998 (see Chapter 8) which seemed to reinforce the fact that the topic was new in the science curriculum offered at CJSS level. Nonetheless, not all teachers shared the concerns about the inadequate materials in the textbooks. It was noted that one teacher had closely followed one of the texts in teaching. When asked to comment on other teachers' views, she said:

I don't agree with them because these textbooks have been used for the two year J.C. even though some of the topics which appear in this three year JC syllabus are not there.

(Obo, Interview, File 1)

It appears that the latter teacher felt that it was a matter of degree of coverage of content that bothered other teachers and not the demands of the new curriculum. However, none of the

teachers cited the philosophy on which the textbooks were developed to be a guiding principle of their suitability for use with the new curriculum. This appeared to result from the fact that the Ministry of Education did not supply any other book for science teaching other than replenishing those for the two-year curriculum. In fact, the importance to science teaching of the two texts was further strengthened when they were supplied to three new CJSS in the region, opened in early 1996.

Overall, the use of textbooks for previous curricula meant that teachers had to come to terms with reconciling how the old and the new curriculum and their materials were related. The situation was made difficult by the fact that there were no Teachers' Guides, which further blurred the meaning and uniqueness of the new curriculum. This is viewed as having affected teachers' effectiveness in the implementation process.

Although the textbook by Chalebgwa *et al.* (1996) entitled, *New Three Year JC Science Revision Notes*, was used in a manner similar to those of the previous curriculum, it seemed to have had a stronger impact on teaching than did the other sets. The impact is reflected by the observed low frequency of their use in teaching compared to *Science by Investigation in Botswana* while, on the other hand, as was shown in concept development, teachers drew a series of experiments and other activities straight from Chalebgwa *et al.*'s textbook. In that way, the influence was more at the level of teacher- than pupil-use. This was verified during the course of classroom observations as I had personal copies for ease of reference. It is the sum total for both covert and overt use in teaching of Chalebgwa *et al.*'s textbook that made it most used by teachers than any other. Several reasons given by teachers account for this.

One teacher said:

We chose it because of the additional benefit of attending to the new syllabus, especially the extended part of the new syllabus... I don't see any textbook fully attending to the needs of the teacher plus the students and to this new syllabus ... Briefly, the 3 year J.C. Revision Notes, is attending to the additional sections of the new curriculum.

(Mrs, Interview, File 7)

Some teachers also relied on it for guidance, though it did not seem adequate by itself. One said:

I told you sometime that err ... I have been dealing with this kind of thing for a long time and I have developed a pattern. I am guided by the syllabus and I use books like these (Chalebgwa *et al.* and Roberts)... I look for essential terms that should go out to them (i.e., pupils)... But at this level, I wonder what I should or should not talk about - for instance terms like blastula, cleavage ...

(Dus, Interview, File 6)

Another reason for the popularity of the book was the authors' influential positions in science education in Botswana. Two were lecturers at colleges of education. The third had been a panellist in the Task Force that developed the curriculum; a former lecturer in science education at one of the colleges and was an Inservice Officer at the time of the study. Furthermore, one teacher said that she had fears that the In-service Officer might be involved in important decisions on national examinations; hence, following the text ensured that the content required for examinations was covered.

The main strength of the book is captured in its introduction (foreword) which states that the organisation of chapters closely matched that of the modules in the syllabus of the science curriculum. It thus offered a quick reference to what could be done in a particular module (Chalebgwa *et al.*, 1996), which possibly confirmed or, reinforced what teachers perceived to be the priorities in the curriculum. Importantly, the book was possibly taken to be based on the interpretation and operationalisation of the objectives in the syllabus document. This factor was possibly a primary consideration in acquiring the book as there were no Teachers' Guides since the introduction of the curriculum into schools in 1996. Neither were they not available by December 1998 at which time the first national examinations from the Ministry of Education had been sat.

However, both *Science by Investigation in Botswana* and Chalebgwa *et al.*'s textbooks were weak on demonstrating applications of science to pupils' environs and experiences. Chalebgwa *et al.*'s textbook contains pure science content, with occasional reference to Botswana, and makes no pretence at contextualising the content:

The text has been written as resource material for both teachers and pupils. ... (to be) used ... as a means of continuously evaluating learning in each module, providing theoretical back up and essential practice in answering questions and examination techniques...

(Chalebgwa *et al.*, 1996, introduction)

On the other hand, the *Science by Investigation in Botswana* textbooks contained pictures and free-hand sketches illustrating procedural undertaking in experiments and examples demonstrating applicability of a certain concepts. However, the pictures and free-hand sketches were not blended with science content but required teachers to link them. In that way, the 'science' in the example is not explored in the text which might, in fact, encourage the tendency to study pure content in isolation. The textbooks seemed to fail to satisfactorily guide teachers in the area of blending science with examples from the environs as required in the curriculum.

As has been indicated, textbooks other than those designed for teaching the previous or current science syllabus, were also used. While the material chosen from the texts was relevant to the concepts taught, it had two weaknesses. First, as in the preceding discussions, concepts were not

related to the local contexts or experiences of pupils. Neither did teachers address the shortcomings. A fitting example here would be of a teacher who, when he taught on ecosystems, accepted without question examples of plant and animal species drawn from a textbook set in a British context. Second, it was noted that the content, its scope and breadth exceeded that typical of science at junior secondary school. Examples of this included the use of the lens formula ($1/v + 1/u = 1/f$) in a revision on the formation of images in the eye; high level chemistry in lessons on the periodic table and carbon dioxide; excessive terminology in lessons on reproduction, the circulatory and digestive systems. One teacher, on admitting the influence of the textbooks said:

It is sometimes really like that. I sometimes feel that we have to take the blame for those things we are talking about. For instance, in dealing with Digestion, I just took a particular diagram in the textbook, enlarged it, and gave it to them. I should have scrutinised it before enlarging the whole poster and giving it to the pupils.

(Pon, Interview, File 6)

One teacher who taught on Blood Circulation, and had four textbooks (including Science by Investigation, Chalebgwa *et al.* and Mackean) sprawled on his desk, said:

I prepared notes looking at them all. When the lesson started, the books were just there. At one point I referred to the books.

(Thu, Interview, File 13)

Against this background, it is fitting that teachers expressed the need to have proper textbooks designed for the curriculum. They clearly influenced and were a key factor in what went on in the classrooms.

5.5.0 Summary

This chapter aimed at providing a description of the general pedagogic aspects observed. Whole class teaching was the norm across all the eight schools in the study. This was illustrated by pupils' seating positions during teaching and by the manner in which instructions and assistance were dispensed. This is the first aspect of the teaching environment to be considered. The second is that teacher-pupil interaction patterns were initiated mostly by teachers, and less by pupils. Lecturing, asking questions and giving instructions were the three predominant modes teachers used for initiating interactions with pupils. The third aspect of the environment is that through their questions pupils showed that they made sense of science and that they could make a contribution to the learning of the subject. This was illustrated by their experience-based questions, examples of which are given. The final section of the chapter focused on notes, textbooks and assignments as they were integral to science teaching. This was partly marked by the amount of time and commitment devoted to them. Assignments were of assorted types and were designed to facilitate teaching.

However, the selective distribution of questions based on a teacher's in-depth knowledge of the pupils' abilities was also acknowledged. The practice did not seem to result in effective stimulation and efficient engagement of pupils in learning. It also appeared that tasks given to pupils were routine or mundane such that they did not provide them with adequate and productive challenges irrespective of individual pupils' abilities. It is unclear whether teaching resulted in pupils acquiring a body of knowledge, attitudes and skills which were satisfactory and adequate for the future requirements of the syllabus.

Also, the experience-based contributions pupils made in class seemed to be ineffectively used by teachers. The contributions had the potential to positively impact on learning had teachers oriented their roles accordingly. On the other hand, lecturing, the extensive use of questions, and the seemingly high *participation* of pupils answering, appeared to have certain consequences. One consequence is that it has not been possible to identify the meaning(s) teachers gave to the curriculum. Another consequence is that it was unclear how teaching addressed the needs of pupils of different abilities. This probably suggested that while classes were generally characterised as having pupils of diverse abilities, teachers recognised the fact in principle but possibly not in practice. The next chapter deals with concept development and will explore these issues further.

CHAPTER 6

CONCEPT DEVELOPMENT IN CLASS

In this chapter, I describe data in order to highlight some aspects of curriculum implementation evidenced through concept development. As was the case in the previous chapter, an assumption was made in the conduct of the study and in the subsequent analysis that transactions in teaching might provide data from which understanding of curriculum implementation could be formulated. Following from this approach five interrelated aspects of curriculum implementation were identified. They are: high content coverage; the utility of pupils' learning experiences; the induction of pupils into learning science; the lack clarity of purpose and intent of classroom activities and the incorporation of-out-of school experiences into teaching/learning.

Each aspect is illustrated via a set of examples drawn from various classroom observations. The *main* examples of themes were chosen based on two factors. One is the extent to which an example clearly illustrated an aspect. The second is the relative frequency with which instances of the main example, or parts thereof, were observed in different contexts. *Subsidiary* examples are provided so as to detach arguments from the main illustration. The fact that the study concerns curriculum implementation demands that a meaningful number of examples should be presented. This is done in this chapter.

There is also a section on *Source of Pupils' Directions* in class. It offers a reflection on those activities which were not covered, or, if covered, were not explicit in the illustrations of the five aspects of concept development. While there was evidence that some teachers experienced some conceptual difficulties in teaching some sections of the syllabus, the matter is taken up in the next chapter.

6.1.0 High Content Coverage

High coverage of science content in restricted time was observed in many lessons during the fieldwork. The lessons, called *condensed lessons* in this work, explicitly, means teaching sessions, or parts thereof, characterised by coverage of relatively large amounts of content within a short space of time. A *lesson* is a planned meeting of 80-minute duration between a particular teacher and a particular class. Central to the criterion of classifying a lesson as condensed are two factors: amount of material covered in a given time, and the mode of dispensing knowledge to the pupils. Following are six examples of condensed lessons:

Example 1: A water closet was discussed in one school as an example of a modern method of sewage disposal. The introduction of the topic was given ample time during which the class visited staff toilets nearby. Pupils typically use pit latrines both in

school and at home. The part on the treatment of the sewage and how sewage water could be filtered and purified was given a quick treatment. Reference was made to micro-organisms, chlorination, aeration, and other techniques, but all in passing. The next activity was transcription of notes from the board, which exercise lasted roughly 25 minutes as the notes were comprehensive, covering aspects of operation of a water closet, septic tank, and possible water purification techniques that could be applied to sewage water.

[Mas, Observation, File 9]

Example 2: In a lesson on reducing heat losses to surroundings through conduction, convection, and radiation, a vacuum flask was used as an example. The teacher lectured, with the flask in hand, and was through with the subject in five minutes, at which time the bell had rang to indicate the end of the lesson. The vacuum flask was not revisited in the next lesson though some notes detailing its structure were given.

[Bai, Observation, File 11]

Example 3: In another school the 'water cycle' was done in about 40 minutes. Concepts of evaporation, condensation, transpiration, and precipitation were variously explained and demonstrated through a simple experiment done by the teacher. The teacher then assembled all concepts into what was said to be a schematic diagram of a water cycle, which pupils copied into their note -books;

[Dus, Observation, File 6]

Example 4: In a lesson that seemingly lacked focus, a teacher dealing with new pupils (Form 1s), who had started the science curriculum in the three weeks prior to my observations, brought out of the storeroom into the laboratory a plethora of measuring instruments viz., mercury-in-glass thermometer; triple beam balance; stop watch; fibre glass measuring tape; and a measuring cylinder. Selected pupils were asked to make measurements using the instruments. No skills or mandatory precautions such as, levelling apparatus and avoiding parallax were imparted to the pupils. Pupils did not appear to demonstrate any such knowledge. Within 30 minutes, the activity concluded and attention shifted to a general discussion on choice of apparatus for making various types of measurements. Some notes were then made.

[Mrs, Observation, File 1]

Example 5: At least three different teachers who were observed teaching on plant reproduction had adopted a similar strategy of teaching. The common practice involved listing out of constituent organs of a given reproductive system and specifying the respective functions of the organs with relatively little contribution from the pupils. Emphasis was on treatment of discrete organs of the system. Extensive notes were made and all teachers had finished the given unit (Unit 8.3: Sexual reproduction in flowering plants) by the end of the lesson.

[Mar, Observation, File 4]

Example 6: In teaching on Water Purification, the concepts on sedimentation, filtration, chlorination, boiling and water desalination in an 80-minute session. In addition, two demonstrations, one on making a filter bed and another on the operation of solar stills were undertaken. The teacher explained everything and conducted the demonstrations herself while pupils looked on. Pupils were given the results that had been anticipated as both demonstrations had failed. They were not repeated.

[Moe, Observation, File 3]

However, teachers' explanations of their practice were characteristically three interrelated factors viz.,; examinations, time and amount of material in the syllabus. One teacher who had taught a condensed lesson on Ecosystem explained:

It is not always an easy thing to do especially if you introduce more than 3 (i.e. concepts) in one lesson. Because you see, in the end they end up confused. The one thing that makes us do these things is that we are at the same time looking at our teaching because our teaching is always examination oriented, because, at the end of the day they have to be examined. We look at the amount of material to cover even though it is at times at the expense of what the pupils should actually know. What pupils should know is better than how much pupils should cover but sometimes if you do not cover certain things, they might be in the examinations ... if I have time, I will do things step by step to try to develop pupils ...

[Rak, Interview, File 1]

Evidence suggests that the teaching strategy to cover the syllabus first, then to revisit some of the topics covered if there were time was integral to teaching and was practised by many other teachers. For instance, in November 1997 (in Phase 1) a teacher began *unstructured* revision sessions at least four weeks before the end of year school-based examinations, in which the teacher was guided by areas of difficulty that pupils suggested and claimed not to understand. Another teacher in a different school attempted a similar approach at roughly the same time. One could suppose that such a teaching strategy was implemented with some sense of shared meaning between teachers and pupils, as the rewards, expressed in terms of revision and preparation for examination, were seemingly tangible and attractive. The practice was also apparent in the first

term of the new school year in 1998 when, as per regional tradition, there were no end of semester school-based tests. In the latter case, and in mid-March, six weeks before the end of the school term some science teachers had already finished their respective set of modules for that term. The observation also gained credibility in view of the fact that not only one class was involved, but many others at Forms 1, 2, and 3.

For some teachers, concentrated coverage of content in limited time was easy. A case in point is that of a teacher who covered all the material for a unit (Unit 1.1.4) on First Aid in 40 minutes. The specific objectives of the module as listed in the syllabus were that pupils should be able to:

- 1.1.4.1 define first aid;
- 1.1.4.2 Demonstrate some simple first aid techniques; treating bites, burns, shock, poisoning and controlling bleeding.

(Ministry of Education, 1995a, p. 1)

On being asked how was it possible to cover the material, she replied:

You think it is too big! ... Well, even though you feel it is a big topic, we teach err ... looking at certain objectives. We do not teach covering everything just because certain objectives are more important to the pupils ... I normally get guided by the objectives from the syllabus but ... sometimes they are a bit very specific and they do not allow us to teach more about a particular topic or sub-topic. So they sometimes restrict us ...

[Obo, Interview, File 1]

While another teacher, who had taught "Making Water Safe", voiced some difficulties and misgivings about the task:

Normally with our kids, it is difficult to explain new terms to them. One reason being that in most cases, they are very few who are intelligent, children who can do what you want as their teacher ... When I prepare for them, I felt I should be prepared to explain out rightly what a residue is. So it was not difficult to prepare for them because I knew we have been doing experiments on this, so when we are talking about the residue they could see that we are talking about something that collects in the filter-paper ... However, I am not even sure they understand what the filtrate could be ... You might find out tomorrow if I ask a question about the filtrate, they will write water. If you change to say petrol instead of water, some of them still say clear water ...

[Pon, Interview, File 6]

While evidence suggests that condensed lessons appeared expedient in addressing teachers' exigencies of time and content coverage, it seems that pupils inadvertently lost out both in terms of participation in concept development and in understanding. This raised questions about the effectiveness of condensed lessons in implementation of the curriculum despite teachers' obligations to complete the curriculum and to prepare pupils for examinations.

6.2.0 Utility of Pupils' Learned Experiences

Topics which had multiple modules in the syllabus provided opportunities to witness how the experience previously acquired was utilised in novel situations. For instance, the concepts of Filtration and Heating. The lessons covering the concepts are used to explore the utility of prior experience in other contexts.

6.2.1 Filtration

The concepts of filtration were covered in two modules of the syllabus, viz.; Module 4: Water at Form 2, and, later in Form 3 in Module 2: Matter. Due to the timing of the study, observations made here relate only to lessons at Form 3 level. The common characteristic of the lessons resides in how concepts were introduced to pupils. Invariably, teachers expected pupils to give a definition of filtration, which reflected the fact that teachers wanted pupils to make use of knowledge they received the previous year. Pupils gave varied answers with some showing a weak understanding of the process. In one case, two pupils gave the following definitions:

Pupil 1: Filtration is the separation of dirty water from clean water;
Pupil 2: Filtration is when we separate water from mud.

[Mol, Observation , File 3]

While the latter are examples of pupils' failure to detach the concept from the example through which it was conceived, the teacher did not respond positively to the problem. Instead, a formal definition was supplied as the teacher proceeded to set up a demonstration of filtration, ironically, using the *muddy water* example. The repetition probably indicated that the teacher did not appreciate the need to expand the knowledge base of pupils. In another case, a teacher spoke of filtration as though pupils had not learnt the concept in Form 2. This time the filtration of muddy water experiment was done in six groups of six to eight pupils each. Pupils were interrupted and asked to label a diagram of filtration while the teacher asked questions requiring recall. That confirmed that pupils had been there before. In a third school where the experiment was done, a teacher-driven demonstration was undertaken as the teacher explained everything to pupils and led them to certain conclusions. "Did you see what has happened?", the teacher said when through with the 10-minute demonstration. Pupils responded: "Yes teacher!" "OK go back to your seats", the teacher instructed.

Two generalisations can be made regarding teacher practice. First, teachers appeared predisposed to repeat content rather than to give pupils activities which could have built on their experience and so broaden their understanding of the concepts involved. In other words, teachers tended to be least bothered by the repetition, perhaps suggesting that they considered the practice integral to the implementation of the curriculum. Second, using a similar experiment in concept development across schools was extraordinary as the syllabus did not provide specific activities for the module. In consulting Chalebgwa *et al.*'s (1996) *New Three Year J. C. Revision Notes*,

widely acquired by schools and which I had for ease of reference, it transpired that a similar set-up was used in pages 35 and 57. The influence of the textbook could not be ruled out, more so that the textbook follows the very same patterning of topics used in the syllabus.

In a related but separate topic on Separation of Mixtures, three teachers in different schools used mixtures of iron fillings and sulphur and a magnet to demonstrate the process of separation by physical means. In all the three cases, the notion of physical separation, its principles and application were weakly presented. Pupils were not asked to present their own examples in which separation by physical means could be possible. Once more, Chalebgwa *et al.*'s carried the activity on page 57, suggesting low ingenuity, flexibility, and lack of diversification of teaching activities by teachers. What was apparent was that the purposes of covering different parts of modules at different levels of education was seemingly least appreciated in practice by teachers, hence the noted repetition of activities. The foregoing is an example of a case in which the utility of pupils' experiences is not tapped by teachers themselves. The experiments on heating illustrates another aspect of the situation. This time pupils did experiments as will be discussed next.

6.2.2 Experiments on heating

Heating experiments invariably involved measuring temperature and were all undertaken by pupils. This provided an opportunity to see pupils embarked on hands-on activities across three different schools. Furthermore, and in contrast to the treatment of the concept of filtration, whose earlier examples were drawn only at Form 3 level, the latter set involved two Form 1 classes and a Form 2 one. The significance of the two Form 1 classes was that one class contained new pupils who had recently transferred from primary school (Phase 2), while the other group was in the final term of their Form 1 (i.e., 9-10 months old in the system, Phase 1). I will first concentrate on the latter two.

The institutional set-up and curricula of primary and junior secondary schools were incomparable. Politically they are one 'establishment' of a ten-year basic education programme. While the differences between the two shall not be discussed here, it is adequate for purposes of this work to state that primary school science is basic with no laboratory or science equipment. Upon transferring to junior secondary, Form 1 is a crucial year as a foundation has to be laid for learning science within the CJSS structure and beyond. Against this background one teacher had to repeat an experiment in which pupils were taught to take readings from a thermometer, as the previous experiment had failed. I observed the class in the latter session in which the teacher dealt with 40-45 pupils. Pupils could not follow instructions; neither did they demonstrate the initiative and confidence in working with minimal assistance from the teacher. This was the first of the two lessons in which I had to join in and assist with guiding pupils in all aspects of the experiment.

However, a repetition of an experiment by a Form 1 class towards the end of their first year seemed surprising. This was in Phase 1 of the fieldwork. The teacher started by giving an overview of previous lesson:

Good morning class ... Last time we drew a graph and covered some theory. We did an experiment and I am not sure if it worked. You took time vs. temperature readings.

[Dus, Observation, File 6]

The teacher went on lecturing, going over the experiment, rehearsing and explaining everything that was done. Following the presentation, pupils were asked to list the apparatus they needed for an experiment that would lead to determining the boiling point of water and the drawing of a heating curve. One pupil said "flame" is one of the apparatus needed, to which the teacher quickly replied: "but flame is from the Bunsen burner!" Perhaps the pupil recognised the flame but not the Bunsen burner. Alternatively, the pupil did not associate the burner with the flame. Apparatus was listed, though, with no justification given.

Having collected the apparatus needed and after the teacher had ascertained that all groups were ready to start, the teacher moved around lighting Bunsen burners for each group of five to eight pupils. They were all instructed to start, albeit with no written instructions. There was evidence that pupils were hesitant. The teacher urged them on, and in the experiment pupils showed inadequate knowledge of how to regulate the flame which resulted in soot covering the beakers. Consequently, the teacher nominated two pupils to run the experiment while other group members recorded data. However, problems with taking measurements persisted:

You are supposed to take the readings at the stipulated intervals which are 1, 2, 3 ... minutes and not 1.5, 2.5, 3.5, and so on. So make sure that you warn others in advance so that they could be ready to take the temperature ...

[ibid.]

Pupils were made to start afresh. In the end, all but one group had a reasonable set of readings which were then adopted for use by the whole class. Rising and falling temperatures during continued heating suggested some inconsistent readings. For instance, readings taken with thermometers out of water, or, with the bulb touching the sides of a beaker. In using data for drawing graphs, pupils committed a wide range of errors, including drawing a time versus temperature graph even though a sample graph was on the board. Pupils were directed to conclusions through two close-ended conclusions - cum - questions:

- 1) Why did the temperature of water increase as time went on?;
- 2) Why did the temperature stop increasing when it reached 98 °C?

[ibid.]

Evidently, the teacher had already made the two conclusions that the temperature of water increased with continued heating which was not necessarily the case when the water started to boil; and that a final temperature of 98 °C was reached, which pupils might have not even realised both in their experiments and in the data they were given. However, although 98 °C was the boiling point of water in the region, its significance in general was not discussed. In a related case observed in another school, it became apparent that some Form 3 pupils' knowledge of the boiling point was detached from their environs. The teacher had asked: "At what temperature does water boil?" About three quarters of pupils raised hands and when the teacher added the qualification "here in Village X", the bulk of the pupils withdrew their offer to answer the question, suggesting that they were not sure of the answer.

Highlights of the foregoing experiment were: it was a repeat of the previous experiment that had failed; there were no written instructions; and, multiple errors occurred which failed the experiment. Pupils' manipulative and investigative skills were noticeably underdeveloped at the end of their foundation year. The structure of the syllabus referred to by teachers as *cyclic* (see Chapter 7) might not have benefited the pupils. However, the teacher's centrality in the practical manifested in various ways, amongst them, the pupils' dependency on his guidance, approval and confirmation that the experiment was performed correctly.

The teacher gave his impression of the lesson:

You were here and you could see what they are doing and to guide them is not an easy job and the number you have to deal with. In many cases, I think it is necessary to repeat and repeat and call their attention to certain things but there is no time - the syllabus has to be completed.

[Dus, Interview, File 6]

Regarding the decision to select a set of readings for use by the whole class, he said:

This is not what should be done ... But, in a situation where you find that some have got the whole thing wrong - with unrealistic readings, sometimes because they removed the thermometer and things like that, then you have to select one set of readings which is ideal for all of them to use in the drawing of the graph.

[ibid.]

On why some pupils incorrectly drew the graph despite having being given guidance and with a model one the board, he said:

The tendency is to give an instruction 1) they may have not understood and, 2) they want to do things their own way. So, sometimes instead of struggling with them, I let them do things their way and as long as they can plot them right, I will leave the rest with the maths teacher. That is the integration part of it ...

[ibid.]

That pupils' experiences in previous modules seemed not to result in the transfer of skills to other instances where they are required is exemplified in a Form 2 practical, the details of which are not rehearsed. In a review of the principles for temperature measurement which preceded a practical, one pupil said a clinical thermometer can be used to measure the temperature of water in a heating experiment. Another gave the temperature of air in the laboratory as -10°C , when the expected value was between 30 to 38°C . It was summer. This suggested that the pupil had not appreciated temperature in relation to his life and environs. The pupil was told what the correct temperature was. Pupils then undertook a heating experiment which had been unsuccessful. While three of the six groups said the temperature of water from the taps was 10.10°C , others had 28°C . This clearly evidenced that the problems with using a thermometer were widespread, particularly when pupils worked in groups. The teacher was angry at the readings, wherein one pupil responded: "*Re ne re saitse gore re tshwanetse gore re dire eng!*", meaning, "*we did not know what we were supposed to do!*" The teacher initiated discussions of ideal observations drawn from a textbook.

One of the lessons learnt from evidence is that basic problems in science teaching appeared to be inherited from the previous year(s). When the problems with thermometers are viewed against the very specific objectives which pupils followed at Form 1, they (the problems) seemed odd. The objectives stated that, *pupils should be able to:*

1.2.7.1. estimate temperature.

1.2.7.2 state that temperature is the degree of hotness/coldness.

1.2.7.3. read the scales of a laboratory thermometer to the nearest degrees Celsius ($^{\circ}\text{C}$).

1,2.7.4. read the scales of a clinical thermometer to the nearest $\frac{1}{10}^{\circ}\text{C}$

(Ministry of Education, 1995a, p. 2)

However, in scrutinising the syllabus for instances in which the use of a thermometer and associated competencies was expressly required, only four were spotted. This suggested that limited opportunities were available to pupils to develop and to reinforce what they had learnt in the introductory module. In view of the evidence and of the diverse abilities of pupils, they did not benefit from the way the syllabus was organised. Neither did the teachers. However, the very fact that the knowledge and skills from the previous modules were underdeveloped is a cause for concern and is indicative of deep-seated problems in the implementation of the curriculum. The next section continues the debate by focusing on how new recruits were inducted into science learning at CJSS.

6.3.0 Pupil's Induction into Science Learning

Classroom observations in Phase 1 of the fieldwork, which was in the last four months of a 12-month school calendar in 1997, were made in an already established culture of teaching where teachers and pupils acted out the negotiated positions in classrooms. The induction into science learning of new pupils (Form 1s) in January 1998, marking the beginning of the new school year, made it possible to see how norms and values in classrooms were initiated. For this reason the interrelated concepts of Mass and Density, both drawn from Module 1 of the syllabus, are used to illustrate what happens at pupils' first contact with the curriculum.

The concept of mass which is fundamental to and pivotal in science and in the understanding matter was introduced in one of the first science modules (Module 1, Unit 1.2.4) in Form 1. The concept of volume and density - are similarly introduced in the same module whose definition and understanding hinges on the former two concepts. Consequently, discussion of teaching concepts of mass and density were drawn from observations made at Form 1 level only. The treatment of the three concepts is not repeated elsewhere in the three year science curriculum. While understanding of volume is a requirement to understanding density, this was not reflected in the teaching. The focus was mostly on the concept of mass.

6.3.1 Concept of mass

The evidence presented in this section was drawn from three different schools, because of the typical one to three weeks time lag in teaching a particular topic across schools. This did not imply, however, the predictability of topics teachers covered at a particular time.

The transaction below captures the way in which one teacher introduced the concept of mass to his pupils:

Teacher: What is mass? Do you know it?

Pupils (en masse): Yes!

Teacher: What is it?

Pupils: (remained silent.)

Teacher: A book ... table etc. have mass ... The material that makes up an object is called mass ... The material in a substance is its mass ... the amount/quantity of matter in a substance is called its mass ...

[Rak, Observation, File 1]

It had not become apparent to the teacher that the three statements were not synonymous. The lecture culminated in the theory being covered in about 30 minutes, inclusive of time for writing notes. Pupils sat at their desks listening to the teacher and transcribing notes from the chalk board.

The notes were followed with a practical in which pupils were to measure mass using a Triple Beam Balance, hitherto unknown to them. Pupils assembled around the teacher's table for a short demonstration on how to use and manipulate the instrument. About seven new triple beam balances were made available for the six groups of seven to eight pupils each, which were all given a common task of finding the mass of their textbook. The practical stalled as the props fitted to the balances for purposes of storage and transportation had not been removed. After solving the problem, it was apparent that pupils were having difficulties with their task. Various groups of pupils constantly referred to the teacher for guidance and assistance, particularly that instructions for operating the instrument were not available for ease of reference.

This was the teaching session in which I joined to assist both the teacher and the pupils in their activity. Although progress was made, my impromptu involvement meant that I was part of the transactions and cannot report on them. But clearly, the restricted time did not give pupils sufficient exposure to the equipment. The development of manipulative skills was weak particularly with seven to eight pupils to a Balance. Some may never have made contact with the instrument. The next teaching session reviewed the experiment followed by activities on calculating volumes of regular objects. This activity paved the way for teaching density in the week following.

6.3.2 Concept of density

A teacher in another school taught density and pupils undertook a practical within the same 80-minute lesson. Pupils' involvement in concept development was noted to be low as the teacher lectured. Pupils were told that "Density is the mass per unit volume of an object", which they were asked to recite. Pupils mumbled and failed at the first attempt. The definition was repeated slowly several times, with more and more pupils gradually joining in the chorus:

Teacher: Do you understand what density means?

Pupils (en masse): Yes Sir!

Teacher: Would you be able to give me the definition next time you are asked to do so?

Pupils: Yes teacher!

Teacher: Is there anyone who does not understand?

Pupils (en masse): No sir!

Teacher: OK, good!

[Gup, Observation, File 13]

Evidently, the teacher was initiating a culture of learning science. Following the introduction, the class started an experiment on Determination of Density of an irregular object, similar to that conducted by another teacher in a different school. A possible influence of textbooks on the choice of experiment could not be ruled out, as Chalebgwa *et al*'s text carried a similar one on pages 3-4.

Pupils were given verbal instructions. For purposes of finding the volume of the object, pupils were told to use '*exactly 100 ml*' (i.e., 100 millilitres) of water. As pupils were novices, mistakes seemed inevitable, but to the annoyance of the teacher:

You students are making a very big mistake. You are supposed to use only 100 ml but when you pour water, it splashes on the sides and you read a lower volume of 98 ml etc ... Some of you use a beaker with droplets on the side and the volume ends up being more ... 101, 102 ...

[Gup, Observation, File 13]

Shortly thereafter, the teacher reproved a group of pupils with a raised voice:

How can you make mistakes like this, You made one thing and you should repeat it all over again ... you, you are using 98 ml instead of 100 ml, make it 100 ml, quick!, quick! ... It is either you do it correctly or incorrectly. Look at this, there is a drop in here ...

[ibid.]

Measuring the mass of different objects with a triple beam balance did not receive any attention in the lesson as pupils were bogged down with problems of measuring volumes. In an interview shortly after the lesson regarding the measurement of volume, the teacher said:

Measuring is a skill which students should master. I believe in precision otherwise it is not worth doing measurements in science. I however noticed problems in the experiment but things should be fine in future.

[Gup, Interview, File 13]

It was observed that some cylinders looked dirty and that 1000 ml measuring cylinders were used for measuring 100 ml of water. Precision could not be achieved because of the graduations in the cylinders. The skills of avoiding parallax and scientific terms such as meniscus were not covered. At the time the lesson finished, with the experiment incomplete, pupils were given the result they should have got. Pupils re-assured their teacher that they could determine the density of *anything* when they had failed to take a single reading. The next teaching session was on processing results which I missed as it fell in another week when I worked in a different school.

Another teacher prepared for the introduction of the concept of density with a review of the concept of mass. Here it was clear that pupils had little understanding of the concept. A typical question and answer session was followed:

Teacher: What do we use for measuring mass?

Pupils (speculated): Cork ... scale ... ruler, Triple Beam Balance.

[Mau, Observation, File 13]

Pupils could also not specify the largest mass the instrument could measure. One pupil, however, suggested the mass as 610 grams which answer the teacher ignored. The teacher then announced the topic of the day - Density. Experiments to determine the density of given objects were started during which the teacher noted that the balances were incorrectly used by pupils. The class was called to order and the proper procedure of their use was explained. Thereafter, one pupil per group of seven to eight pupils was selected to operate the balance. The use of a measuring cylinder and displacement can were not discussed as was the case during the review (introduction). The practical failed, possibly suggesting not only weak organisation but the lack of the skills required of the pupils.

It appears that teaching Density followed a similar pattern across schools. It is as though teachers had high expectations of their pupils and of their abilities but failed to identify those who could be effectively exploited in the practical activities and in concept development. The experiments and the use of multiple types of apparatus overwhelmed both the teacher, in terms of class organisation and management, and the pupils. On the other hand, assumptions were probably made by teachers about the worth of knowledge from previous modules. This is revisited in Chapter 7 where teachers claim to find prior knowledge easy to use in conceptual development.

Generally, teachers were inadequately prepared for the tasks. If they were, it would seem that the teaching strategies they adopted were insensitive both to the needs of the pupils and to the curriculum itself. In retrospect, the earlier illustrations (heating experiments) in which repetition of some tasks were noted appear to reinforce arguments that foundations laid for science learning seemed inappropriate or weakly developed to support the implementation of the curriculum. Further examples of the phenomenon follow.

6.4.0 Clarity of Purpose in Teaching

The question is whether the purpose in teaching was clear to pupils and from the teaching environment. A practical session on Food Tests and the other on "Properties of Matter" are used to explore the issue.

6.4.1 Food tests

There were three instances in which issues on Food and Nutrition were explored. While two involved straight lecturing, with teachers mounting demonstrations on Food Tests, the one described below had a set of practicals undertaken by pupils. During the practical, I talked with two groups of pupils in order to gain their explanations of what they were doing. The transactions below were done when various groups were testing for glucose in a salt solution. The following interchange ensued:

- Researcher: What do you want to find out in this experiment?
 Pupil A: I don't know, it is the teacher's suggestion because this is not in the book ...
- Researcher: What results will you get?
 Pupil B: ... red-brown colour.
 Researcher: Why?
- Pupil C: ... we are repeating the experiment but this time with salt and no sugar so the red-brown colour will be there.
- Researcher : What does the result tell you?
 Pupil B: .. that starch is present!

[Moa, Dialogue with pupils, File 12]

In asking similar questions to another group, the following responses were obtained:

- Pupil D: We expect to see a colour change
 Researcher: What colour will it be?
- Pupil D: ... red-brown or some other colour ...
- Researcher: What does the colour change signal to you?
 Pupil E: There is starch ...

[ibid.]

One observation is that pupils seemed not distinguish between the tests for glucose and for starch, or rather, used the two terms interchangeably. The pace at which they performed the set of experiments appeared to be fast for pupils to assimilate the information. There were no review sessions in between the different activities. While some groups had not yet completed the above experiment, the teacher announced the next activity: Test for Fat. Pupils were referred to page 186 of Book 1 of *Science by Investigation in Botswana*. This experiment was left incomplete by the end of the lesson. Neither were the previous ones reviewed. Instead, pupils were given a table in which to enter their results for discussion in the next lesson the following day.

Evidence suggests that pupils might have perceived collecting data as the main purpose of the experiment. This appeared to be supported by an interest the teacher had in using the results to categorise given food samples. The latter fact is supported by data from an interview with teacher:

- Respondent: It (purpose of experiment) was to make the pupils know, first, the test, the chemical that is used in the food test, and also for them to see the results of the food test.
- Researcher: How about conducting the experiment itself, was it not part of what you wanted them to learn?

Respondent: ...Yeah, it is hard for them to do it on their own, that is why even though I gave them the instructions, they were not able to follow them. So it is hard for them to do the experiment on their own, they need close supervision and guidance of the teacher. ... The language factor contributes a great deal ... It also appears they did not know the importance of the experiment. They do not know why they are in school! This one is a general observation. But it is like the experiment is not a serious thing which can help them pass their examinations in future!

[Moa, Interview, File 12]

While the teacher concurred that she had told pupils that the colour indicating presence of starch is blue-black and not black, she explained:

Well, because it is a general thing that the blue-black colour signifies the presence of starch in food. The questions that are going to come in the exams would require blue-black colour so they are supposed to know that the blue-black colour is the colour for starch. If I tell them that it is black, they will be confused in the exams. The examinations from the Ministry recognise blue-black!

Following from apparent uncertainty over results during the practical, and hence perhaps showing that some activities were undertaken for their assumed intrinsic worth in teaching, the teacher said:

To tell the truth, with the glucose test I was not aware that the results would be a red-brown colour. When I realised that the red-brown colour is what they are seeing, some of them said they think it is familiar, it is a common thing!

Activities in the class were performed as a matter of routine, emphasising the acquisition of scientific knowledge, though that was not done in a critical manner. Pupils collected information which seemed to mean little to them. The next example elaborates this observation.

6.4.2 Properties of matter

Another lesson in which Form 1 pupils (4-6 weeks in school) undertook activities which probably meant little to them involved the teaching of concept of Matter. It was as though the teacher wanted pupils to acquire orthodox scientific knowledge because the activity was structured such that it left little or no room for pupils' self-expression and discovery. The specific objectives of the lesson contained in the syllabus and recounted by the teacher stated:

Pupils should be able to:

- 2.1.1.1 define what matter is.
- 2.1.1.2 describe that matter is made up of particles.
- 2.1.1.3 list properties of matter.
- 2.1.1.4 Carry out activities to demonstrate these properties.

(Ministry of Education, 1995a, p. 3)

Following a brief activity in which pupils gave examples of solids, liquids and gases, they were given tasks to investigate typical characteristics viz.; solids and liquids. The first activity undertaken by pupils was on investigating characteristics of solids. The following set of guiding questions were written on the board:

- a) How are particles arranged: are they close to each other or far apart? Give reasons for that;
- b) Try to squeeze the block you are given. Is it easy to squeeze? Why?;
- c) Measure the **mass** of the block. Record its **weight**. Is it light in weight or heavy?;
- d) Look at the shape of the block of the solid. Is it fixed or it takes the shape of the container?
- e) Heat the block using tongs. Does it conduct heat or not? (allow the heat to pass through).

[Moe, Observation, File 3]

Some contradictions were apparent in the above instructions. At the time pupils had not covered the concept of weight (as confirmed by the syllabus) or the difference between it and mass. The concept of weight had not been explained nor was the method of its calculation. The question on the shape of the solid was invalid as pupils used a solid metal cube. Instruction (e) was self-contradicting because if pupils were to allow the heat to pass through, then the cube conducted heat. It was also not clear how they would tell if heat had indeed passed through.

During the activity, I walked around the class to see how it progressed. I noted that pupils had difficulty with the Triple Beam Balances. They had also recorded that the metal cube, which was approximately 20 millimetres per side, was heavy. On being asked why by the researcher, the pupils could not explain: it was a subjective judgement, or rather, they had simply chosen their responses from the alternatives on the board. Thus, a particular view(s) of the nature of solids was ingrained in pupils through the practical activity. A similar approach was followed in experiment investigating the properties of liquids. The lesson was one of the instances in which my conscience forbade interviews on observations. I also believed the decision rested on sound professional and ethical judgements which took into consideration the possibility that the teacher might have known her teaching weaknesses. An interview with her was, therefore, of a general nature.

I also noted that some teachers sometimes directed individual pupils to answers *privately*. In at least two instances I found that instead of giving pupils guidance in activities, teachers had directed them to answers which pupils could not explain. A case in point was in an activity on labelling parts of a flower. On being asked for the basis of labelling the flower as she has, a pupil replied: "*I got this from Mr X, he told me to label it as such*". A similar response was made in another school where pupils were given samples of igneous, metamorphic and sedimentary

rocks. It appeared, that pupils could not tell the difference between the three despite having covered some theory on rock types. At one stage, the teacher complained that the unlabelled samples were to move the class around in a particular order, which pupils had not observed and hence their difficulties in classifying the rock samples. It seemed this activity was one of the many which probably did not lead to pupils' active engagement in science learning, and whose purpose was not identifiable from the conduct of the task itself. Both the flowers and rock samples derived from pupils' physical environment and pupils were not asked to make contribution of their knowledge of the samples. In the following section, pupils were engaged in activities about which contributions were actively sought by teachers.

6.5.0 Incorporating Everyday Experiences into Learning

The syllabus mentions the use of pupil's everyday experiences in science teaching. It has thus become an important consideration to find out how the experiences were brought into and incorporated into science teaching. Lessons on First Aid and Pregnancy were the only two during fieldwork in which teachers committed significant amounts of time to soliciting pupils experiences for use in teaching. Discussion of the activities in the lessons is undertaken below. The third part of this section takes a reflective overview of the transactions and seeks to locate the teachers in classrooms with respect to out of school experiences of the learners.

6.5.1 First Aid

The lesson was part of a larger unit on safety in the laboratory, one of the first topics taught to new students (Unit 1.1.4 of the syllabus). What was peculiar about the lessons, though, is that the teacher lectured first for about 40 minutes on modern (i.e., conventional or western) First Aid before the activity.

In the activity, pupils gave socially held experiences through a written group work exercise. The task, *how first aid is done in home, the traditional way*, focused on the following areas:

- a) burns and colds;
- b) wounds and nose bleeding;
- c) stomach ache and eye injuries;
- d) snake bites;
- e) and broken bones.

Table 6.1 to 6.4 display the pupils' findings. They were copied verbatim from photocopies of their scripts.

BURNS	COLDS
a) A raw egg is applied to the burn	You boil eucalyptus leaves and drink the solution.
b) You can put fermented sorghum.	You can boil lemon slices and drink.
c) Put the burnt area under running water. (5-10 min)	You can apply vicks.
d) Apply wet salt.	Boil water, cover your head and sniff the steam into your nostrils.
e) You can apply the sap from cactus plants.	Mix water with salt, swallow the solution so that you can vomit (see note 1).
f) You can face the burnt part to the fire.	

Table 6.1: Pupils' Knowledge of First Aid for Burns and Cold

Note 1. The practice is common amongst members of the Zion Christian Church, spiritual churches and faith healers. The practice is also practised by some traditional doctors. Some people, however, do administer this to themselves, family members and close associates.

NOSE BLEEDING	WOUNDS
i) By twisting his/her hair	You can wash it with water with salt or soap
ii) By pressing his/her blood vessels	You can put apply methylated spirit.
iii) By pouring cold water in his/her head centre	You can bandage with a clean cloth after washing a wound
iv) By putting hot coals so that blood will drop in that hot coals (magala)	
v) If you are in the way going somewhere you can sit under the shade	
vi) You can smoke a thread of sack.	

Table 6.2: Pupils' Knowledge of First Aid for Nose Bleeding and Wounds

STOMACH ACHE	EYE INJURIES
1. I wrap my stomach with scuff after that I lay down with my stomach	When something get in my eye someone would come and blow it out
2. When I have stomach ache I drink sengaparile (see note 2)	Sometimes I can wash it with water.
3. Sometimes when I have stomach ache I eat soft porridge with milk	
4. When I have stomach ache I can go to the toilet	

Table 6.3: Pupils' Knowledge of First Aid for Stomach Ache and Eye Injuries

Note 2. Sengaparile is a medicinal herb otherwise called Devil's Claw or Grapple. Its botanical name (according to one pharmacist in Botswana) is Harpagophytus Procumbens. The scientific name is Harpaboron. The plant grows in abundance in the sands of the Kgalagadi Desert and in Namibia. The plant has lately been commercially exploited as it cures a wide range of ailments such as stomach ache, rheumatism, arthritis and others. The tubers of the plant are harvested, pulped and dried out in the sun. This is then sold locally in small packets and the bulk is exported to Europe where it is processed into tablets. It is available for Boots The Chemist in UK.

SNAKE BITES	BROKEN BONES
1. In traditional to treat snake bites you take cow dung and mix it with milk, then you stir after that you drink to reduce some pains.	In home when your bone is broken the traditional doctor can join the bones together. This is called (thobego) (see note 3)
2. The you apply wet salt on the bite and wrap it with a clean cloth	In tradition when your bones are broken the traditional doctor can put two straight wood both sides of the broken bone and poor traditional medicine and bandage it.

Table 6.4: Pupils' Knowledge of First Aid for Snake Bites and Broken Bones

Note 3: Thobega is a highly regarded way of mending broken bones. It is practised both in humans and animals though the skill is fast becoming extinct. It is, however, practised in some communities remotely located away from modern health centres.

Pupils made oral presentations of their findings in class. The findings were experience-based and some were utilitarian, while others rested on (ritual) practices or (spiritual) beliefs. As pupils made their presentations, the teacher attempted to explain the science of each technique, though with difficulty. When the teacher drew parallels between traditional practices and formal science, and stated that traditional First Aid activities emphasised utilitarianism/pragmatism, and were invariably seen as practices which work, or were believed to, but never were explained. The activity clearly showed that pupils were knowledgeable on some aspects of traditional First Aid and that they could make some contribution in that field. However, the dilemma was that pupils appeared to be led into believing that their experiences had limited contacts with formal science.

In a similar case, one teacher sought his pupils' knowledge on smoking and later had to contend with their arguments that smoking had some medicinal benefits. Nevertheless, the teacher rejected this and created yet another instance in which science in school and in social life as these manifest in pupils lives seemed incompatible. The purpose of asking for pupils' contribution of their experiences had thus not been clear, particularly regarding whether teachers sought only those experiences which the teacher considered scientifically. The problem is illustrated by one more example. Here the teacher used an analogy whose purpose in concept development could not be identified from the teaching context itself. The following transaction on cross-fertilisation is appropriate:

- Teacher: ... even at home you are not allowed to have a baby with your brother or sister... Can you have a baby with your brother or sister?
- Pupils (en masse): Yes, we can!
- Teacher: (Repeats the question)
- Pupils (louder!): Yes we can!
- Teacher: I can't deny it is possible but it is not allowed for various reasons. The same applies to plants ..

[Mar, Observation, File 4]

I saw difficulties with this analogy as it's use in teaching seemed to have been prematurely terminated. For instance, pupils were not engaged in a debate seeking explanations of their position. The paradox was that the disparities in the perceptions of phenomena as held by pupils and their teacher were ignored. And, it was difficult to see what the teacher made of the situation. One commonality of the above sets of examples is that they were all made at the concept application stage in concept development. The next example is different, and is the only one in that pupils' experiences were not seen in isolation, but were integrated into the mainstream of concept development.

6.5.2 Lesson on pregnancy

This time the lesson involved Form 2 pupils in the first term who had covered some aspects of reproduction at Form 1. The class activity required pupils to list the signs of pregnancy that they knew. The following were arranged in the order in which they arrived. The verbal interchanges that each response resulted in are presented in context. They are:

- a) *A pregnant woman demands a lot from other women*, said a pupil. The teacher seemed astonished and said not all women do that. The class agreed.
- b) *A pregnant woman gains 6 to 9 kg*. In response, the teacher asked: *what can you say about the weight: does it increase or decrease?* Pupils said it increases and this was put on the board. The teacher's preference for weight to mass is noted. (see also the section above on properties of matter).
- c) *The diet of a pregnant woman should have a lot of protein*, said a pupil. The teacher enquired if that was a sign of pregnancy; the class was unanimous that it was not.
- d) *She wears a maternity dress*. Teacher enquired: "is it true or false?" Pupils said it was true though this was disputed by the teacher on grounds that only physical changes on women were being considered.
- e) *She becomes lazy and eats too much*. Other pupils concurred with their colleague that it was indeed true. The teacher said that instead of 'lazy' they should say *tired*. She also proposed the use of *reluctant* as a further qualification of their statement. Pupils rejected the proposals. As one argued, when pregnant women wake up in the morning, allegedly after a rest at night, they had been observed not to be active and usually sent children on errands. In that way, pupils opined that pregnant women were lazy, and thereby drew distinctions between the latter phenomena and tiredness or reluctance.
- f) *A pregnant woman quarrels any time*, alleged a pupil. The teacher suggested substituting *moody* for *quarrel* which pupils rejected on grounds that moody is too broad to be seen as an alternative or equivalent to quarrel. One pupil drove the point home by saying that one might be moody but would not always quarrel. Nonetheless, the teacher included *moody*, her characterisation, in the list being compiled.
- g) *The stomach becomes big*. The teacher said that since they were not talking about a digestive system the pupil should have said abdomen. This point is related to d) above but had not been raised at the time.
- h) *... breasts become large*. The point was not challenged.
- i) *... they cannot talk a lot*. At this point the teacher told the class that the focus is on physical change and not change in behaviour. However, there possibly could be some

biological basis in pupils' observation particularly relating to changes in hormones in the body.

- j) *They become light in complexion* . This was not debated but taken as it was.
- k) *Their legs become swollen*. The teacher noted the point but substituted thicker for swollen.
- l) *Menstruation stops*. The teacher asked for a definition of menstruation. One pupil said that "it was a monthly flow of blood through vagina", which definition was met with scepticism by the teacher who asked for a more refined explanation. Another pupil's definition was succinct: "... is a unfertilised egg coming out of the walls of the uterus through vagina in the form of blood". This was accepted outright by the teacher.

Pupils' contribution/knowledge posed a challenge to the teacher as their information covered both physical and emotional factors while the teacher focused only on the physical factors. Also, pupils framed answers in their own language and the teacher constantly steered them to her interpretation or language which she felt appropriate. In an interview, the teacher said that she considered it her duty to direct pupils to the answers she expected of and wanted from them. As the teacher later revealed, she wanted views supported by those documented in textbooks as the knowledge was valid for examination purposes; suggesting that the currency of what should be taught was also judged against its value in examinations.

The above example contains instances in which there had been knowledge conflicts and differences of interpretation due to different views held by the teacher and her pupils. However, the teacher stated that it was better to tread a neutral ground (i.e., established scientific knowledge) than one value-laden and loaded with information whose validity could not be easily established. The teacher said there was a dilemma of acceptance of pupils' contributions when they conflicted with her's. Furthermore she said that letting pupils bring their experiences into teaching could be a regrettable experience particularly when they challenge one's authority. What the teacher said she feared most was the possibility of pupils holding polarised views for which she might have no answers or only those which would alienate her from the class. The example above is indicative of the challenges faced in teaching. Of interest is how the teacher battled throughout the lesson to define the scope of deliberations. The problem of alienation from pupils was apparent. Her fears of alienation from class were demonstrated in several other instances in other schools.

There was one main instance in which the teacher was alienated from his class as he did not seem to share in pupils' perspectives or understanding of phenomena. Events that are recounted below are of the main example and relate to a stage when the focus was on water vapour as one of the constituents of air. The lesson was at a stage when the teacher had asked: "*when can we have little water in the atmosphere?*"

One pupil said water vapour is low in the atmosphere when it is cold, which answer the teacher accepted. I would have thought it was low when the land is hot and dry but high when it is cool as in the morning. Another pupil, answering the same question, said water vapour was low "when there is sunlight". The teacher responded:

Sunlight, is it? I think you are guessing. What is water vapour, if I may ask?

[Kea, Observation, File 5]

In fact, the latter pupil's response probably contradicted the other response in that the sunlight could be, or is, associated with hotness (warmth). On the question of what vapour is, the following verbal exchange occurred:

Pupil 1: ... sometimes we get it after rain

Teacher: I did not say when but what is water vapour!

Pupil 2: It is a moisture of a water droplet!

Teacher: Is it? Yes! ... (pointing to another pupil to make an attempt)

Pupil 3: (remained silent)

Teacher : .. water vapour is the gaseous state of water. When it is very hot, there is very little of it in air but when humid you get loads of it in air ...

[Kea, Observation, File 5]

This explanation is noteworthy in that it appears consistent with the view that water vapour is low "when there is sunlight". The responses from pupils were clearly framed within their everyday experiences and modes of self-expression which are seemingly devoid of formal scientific terminology. On the other hand, the responses reflected the ingenuity of pupils attempting an answer to questions framed within the context of their daily experiences, but whose explanations, paradoxically seemed to be confined to formal science. This warrants a brief look at what teacher's positions emerged in contextualising the curriculum.

There were several subsidiary examples of teachers alienated from their class apparently because the examples teachers gave in class appeared to reflect their (teachers') socio-economic positions rather than those of the pupils.

6.5.3 Out-of-school experiences and the teacher

One teacher had a solar water heater at her residence within the school bounds, and was oblivious to the fact that pupils did not have similar facilities in their homes. On being asked how she had related the topic on heat transfers to the everyday lives of the pupils she said:

I think if I am talking about the solar panel, the water which they get from it, which is hot, from experience they understood the relations.

[Bai, Interview, File 11]

While she concurred that pupils did not have solar water heaters in their homes, she still felt the example was appropriate:

It is not irrelevant to their experiences but that is how it can be used in some cases. The same applies to the car cooling system, they are not familiar with them but we still have to do it.

[ibid.]

The two (i.e., water solar heaters and cooling system in cars), in addition to a vacuum flask, had been the only examples given both in the syllabus (Unit 6.4) and in class to demonstrate applications of the principles of heat convection, radiation and conduction. Two further examples showing that teachers sometimes thought they shared similar experiences with their pupils seem appropriate.

One teacher asked his pupils: "*Do you know satellites? I can talk to someone in America using a satellite. Am I right?*" Pupils: "*Yes sir!*" When interviewed about the incident, the teacher said he expected pupils to have had the information on the solar system from "*primary school science or wherever*". TV satellite dishes (aerials) are a fairly new item in Botswana, as their widespread use started in June 1998, following changes in South African Broadcasting Corporation's transmission meant to enable collection of TV levy from viewers in Botswana. Another teacher gave pupils an example drawn from a TV news (item) in which a man who had swallowed cocaine wrapped in condoms. Very few, if any of the pupils had access to TV mainly due to their socio-economic status. In one school, a coloured TV set brought into class for showing a video on "Blood and Circulatory the System" had stirred some excitement amongst the pupils. Its arrival had earlier been marked by some cheering. The national television station for Botswana is proposed to start operating in October, 1999.

Clearly, elements of science were presented as sterile knowledge. Incorporating everyday examples into its teaching faced a wide range of challenges. So far the focus has been placed on what the teacher did. Less emphasis has been on the learners. The next section looks at what learners did in class in order to create a fuller understanding of the teaching environment.

6.6.0 Source of Pupil Direction in Class

In this section, an outline is made of some aspects of teaching which remain unclear because of the organisation of research findings in this chapter. A change in vantage point in which concern shifted to what pupils did, and not to their teachers appeared necessary. In terms of data analysis, this step enhanced chances of maximum use of data. From a methodological standpoint it enabled maximum use of data and its interpretations. Only data which has not yet surfaced in the preceding sections of this chapter is considered. This was accomplished in two ways. One was to look at what consequences resulted from the dominant forms of teaching that have so far been explained. This meant creating links with data in the last chapter. The second strategy was to search for 'missing categories' in the data.

In the previous chapter, lecturing and question and answer sessions were reportedly the main modes of teaching. Allied to that teachers were seen as either doing class demonstrations or, where practicals for pupils were mounted, instructions were either verbally communicated to pupils or written on the board. The latter was done sparingly. Furthermore, a notable dearth of handouts for pupils was evident in the data. This was supported by the fact that no more than seven samples of handouts meant for pupils were collected during the fieldwork. The latter observation was also corroborated by the high use of textbooks by teachers and pupils. A section is devoted to use of textbooks in Chapter 5.

Another area to which evidence directs our attention was that of the minimal practical work for pupils. Demonstrations by teachers were slightly more numerous than were practicals for pupils. However, this was not to the extent that it could be concluded with certainty that demonstrations were done most of the time. At most 15 demonstrations were done by teachers, excluding the five that failed. Also, a total of five basic experiments, were not undertaken. On the whole, a total of 11 practicals were done by pupils. This anomaly should be viewed in light of observations that fewer than five teachers had, in passing and in interviews on some other subject, hinted at or alleged the inadequacy of science apparatus in their respective schools. However, as was observed during fieldwork, a wide range of equipment existed across schools. This included video cassette players; colour television sets; overhead projectors; charts; quantities of assorted glassware, chemicals and other science apparatus which possibly suggested a materially favourable environment for both teaching and practical work. However, and as discussed in the next chapter, apart from the teaching loads and other work commitments teachers also acted as laboratory technicians as none were available in any school in the study. This might have impacted negatively on teacher preparedness to use the materials on regular basis.

The data shows that there some instances in which pupils supplied answers which were least anticipated or were far off the mark. At least 30 such contributions were noted. The majority of

the answers occurred in introduction sessions when teachers attempted to foster a link between the old and new concepts. The wrong answers can be placed into categories such as misconceptions, conceptual difficulties, misunderstanding and simply, wrong ones. Incidentally, some teachers gave priority to covering what they had planned for teaching over and above that which was unplanned and contingent. This arose frequently in the interviews as in the four instances in which some teachers had to leave out notes because they felt the activity could slow down the pace of teaching.

Related to the fact that teachers set priorities to planned tasks, it was noted that pupils received limited feedback on their mistakes. This was illustrated (see Chapter 5, Table 5.1) by high numbers of teachers searching for correct answers while, in the process, ignoring those considered inappropriate. Also, where verbal feedback was promptly provided and to the degree that it appeared satisfactory, pupils were not directed to correct their own work as though it were assumed they would do that automatically. Also, there was no balance in the contribution of fast and slow learners as sometimes pupils answered at will when s/he felt s/he knew the answer to a question. While wrong answers were disregarded, some were met with rebuttal:

If you have got it wrong, you have got it wrong! Proceed to the next question ... some students have the tendency of not bringing forth their work for marking, they sit until the end of the lesson! (adding, after giving an assignment) ... some of you are going to copy answers verbatim from the texts without comprehending the content itself!

[Mok, Observation , File 10]

One illustration of the problem is captured in the following interchange:

Teacher: How does a chameleon adapt to its surroundings?

Pupil 1: By waiting for it's prey

Teacher: That's not a correct answer, another student please!

Pupil 2 (reading from textbook): It changes the colour of its coat so that it matches with the surroundings
[The answer was accepted]

Teacher: How does a crocodile adapt to its surroundings?

Pupil 3: By basking in the sun!

Teacher (gave his response): ... eyes and nose are on top of its' head so that it can submerge the body and only eyes and nose can be above water. ... How does a tortoise adapt to its environment?

Pupils: [remained silent]

Teacher: the hard shell protects it from being eaten by other animals.

[ibid.]

The teacher rejected the answer on adaptation of crocodiles despite the fact that crocodiles also need *warmth* and comfort particularly in winter and when resting. A similar concern could be raised regarding the fact that indeed a chameleon would lie in wait in places where chances of getting a prey are 'reasonable'. One probable reason pupils gave such answers was because some animals referred to were unknown to them and they only saw them in the pictures. The answers that pupils gave were their own (i.e., pupils) interpretations of the photographs, as in the case of the adaptation of crocodiles. However, there was clear evidence that the teacher subscribed to a restricted meaning of adaptation while, it seemed, pupils gave answers requiring a broader perspective of the concept. Paradoxically, the teacher had marked the work although that did not seem to influence his teaching.

An apparently neglected area was that of giving pupils written tests either on a weekly or a monthly basis. Although I was itinerant, the length of my stay in each school in each phase of the study should have made it easy not to miss some tests. Nevertheless, at most four tests were announced in my presence. As part of their practice (see next chapter), teachers moved from one topic to another in the syllabus without reviewing the preceding topic, hence the progress pupils made during teaching was poorly monitored. One of the test scripts I happened to obtain was for a test which had been due in the previous school term but was done in another term as the teacher had to enter the mark for the particular month the test was due.

6.7.0 Summary

This chapter was predicated on the assumption that teaching itself embodied information about the process of implementation of the curriculum. Two key observations were made in this chapter. The first was that teaching pure science content seemed to have been given more emphasis than 'contextualised' science incorporating everyday applications of science as well as pupils' experiences. Generally, applications of theory to examples drawn from real-life were limited, weak and underdeveloped. The same could be said of experiences pupils brought into teaching. Their position in teaching seemed unclear and, at best, subsidiary and peripheral to science content. If the latter assertion is true, then it would seem that they negatively affected both the teachers' and pupils' enthusiasm and commitment. Consequently, with the predominance of conventional science teaching, the relative merits of integrating pupils' experiences into science teaching have not been apparent. This tends to lead to questions of the priorities set within the syllabus, how they should be realised in practice, and how teachers re-conceptualised their roles in response to the curriculum changes.

The second observation is that, while pupils encountered much new knowledge in science lessons, teaching failed to effectively link this with what learners already knew, or were expected to know. Apparently some activities were done for their assumed worth in science teaching, leading to lack of clarity of purpose and intent of lesson. The situation seemed to result in pupils

making few gains in skills, attitudes and knowledge for future use. Further, the merits of mixed ability and whole class teaching as the key modes of curriculum implementation were not conclusively clarified through the data on concept development. It also was difficult to identify which ability group of pupils teachers targeted as there seemed to be no clear activities to show the favoured group. The latter observation should be viewed in light of *condensed lessons* which tended to address the exigencies of time, syllabus coverage and examinations.

This chapter was deliberately *observation-based*, while teacher perspectives on their practice are reserved for the next chapter. The next chapter attempts to expound on some observations contained in this and the previous one.

CHAPTER 7

TEACHERS' PERSPECTIVES ON THE CURRICULUM

While the previous chapter was *observation-based*, this chapter presents teachers' perspectives on their practice as a way of obtaining an informed understanding of classroom observations. As Huberman (1979) states, "we must judge the significance of change in terms of the meaning that it has for the acceptor .. what counts is the relative importance he attaches to the personal advantages of each change" (p. 22). Teachers' views in the semi-structured interviews provided their value positions and the basis on which some of their actions can be understood. The perspectives relate to the findings in Chapters 5 and 6. Three sections have been developed.

Three key components defined the curriculum. In the syllabus document, these are: its nature; the general and specific objectives of what should be taught; and, 'contextualisation' of the science taught to pupils. The first section concerns teachers' understanding of the philosophy and nature of the syllabus. The observations in Chapter 5 and 6 showed that the prevalence of lecturing and questioning in teaching failed to show how pupils of different abilities were accommodated in teaching. This point forms the basis of the section which seeks teachers' perceptions of pupils' and how that impacted on the implementation of the curriculum. Teachers' views are evidenced through direct quotations from interviews. The chapter ends with a summary of certain factors which emerged as influences on the implementation of the curriculum.

7.1.0 The Syllabus and Curriculum Implementation

This section explores how the syllabus was a factor in curriculum implementation. First we focus on the position of the syllabus in teaching. Teachers' views on three key areas of the syllabus are presented later.

The syllabus was a key factor in implementation because there were no other documents (Teachers' Guides, worksheets) from which teachers could obtain guidance. The central position of the science syllabus in the implementation of the curriculum was also evident in a number of ways. For instance, it brought into teaching some administrative or organisational influence across schools in the region. Particularly at the beginning of a school term, with the exception of those in the three schools opened in 1996, teachers were found to be finished with the modules of the previous term. Also, all the teachers in the study had covered topics as arranged in the syllabus. For instance, one teacher had changed from a module on Blood as Transport System to Food Production in Plants. Another had changed from Acids and Bases to Extraction of Minerals, while another moved from Digestive System to Blood as Transport System.

The changes seemed abrupt as no teacher had been observed to make a detailed revision of the preceding topic prior to starting a new module. The changes were sometimes made within the same lesson when another module finished. One teacher, who changed in one lesson from a module on Water to one on Reproduction, explained:

I can say we have not yet sat together as teachers here and decided how to sequence our topics. We just took them as they are in the syllabus ... one other thing is that though the syllabus does not say we should follow it as it is, I personally realise a loop hole there because if I am going to follow the syllabus the way I want, and one teacher somewhere follows it in a manner he/she is comfortable with, it means that when we do transfers, children are really going to get a lot of difficulties because most of us will not be dedicated that much to ask the child which topics they have done or skipped with a view to helping them out during our spare time, if it needs be.

(Pon. Interview, File 6)

Some teachers said they had never thought about the organisation of topics before and had covered them in the same sequence as presented in the syllabus. It seems the syllabus was implemented without reorganisation of topics whenever teachers felt appropriate.

Teachers also had views on three areas of the syllabus. The three are: a) instructional objectives; b) the 'cyclic' nature of the syllabus and c) the subject matter. Each of the three areas is discussed with emphasis on finding meanings or explanations teachers had about the curriculum. Finally, and as a corollary to the three areas, teachers' levels of confidence in implementing the curriculum are explored.

7.1.1 Instructional objectives

The syllabus was expressed only in terms of general and specific objectives. It is stated that:

For each topic **general objectives** which give rise to **specific objectives** have been derived. The specific objectives describe what students are expected to do; this includes applying basic science process skills, interpreting natural phenomena, understanding and applying scientific principles.

(Ministry of Education, 1995a, p. i).

Teachers invariably queried the use of general and specific objectives, particularly as they had uncertainties over content and both teacher and pupils activities prescribed or necessary to realise a particular objective. One point that had been noted during interviews with teachers was that they did not develop their own instructional objectives. Instead, they followed those in the syllabus. The practice of teaching to objectives seemed to gratify some teachers as it tended to give them a sense of achievement. For instance, when asked what objectives she had set for her three lessons on Heat Transfer, one teacher said:

There objectives are there in the syllabus, so I just based my work on them. For instance, I had to state methods of heat transfer; and then state their applications. I was teaching looking at the syllabus ...

(Bai, Interview, File 11)

Another teacher, who had dealt with the topic of 'Components of Blood' in about 40 minutes, explained:

Actually, I did that following the objectives ... I had three objectives to achieve ... I copied the objectives in the syllabus.

(Thu, Interview, File 13)

However, some objectives seemed elusive as some teachers found that the syllabus did not provide adequate guidance regarding the depth, scope and specification of content. Furthermore, difficulties in testing whether some objectives were realised in teaching had been noted. One teacher said:

... most of the objectives are just too general. They are supposed to be specific objectives but they are too general. Most of them seem to be too shallow like, an objective would say, students should be able to investigate or the teacher should demonstrate ... such objectives become very difficult to test ... most of the objectives do not involve the student. It is the teacher who is mostly involved ... most of them just requires the student to list ...

(Mas, Interview, File 13)

The expression that objectives '*do not involve the students*' appears to show the inaccessibility of meaning or transparency of some objectives to teachers on the one hand, while on the other, it may explain the predominance of lecturing, question and answer sessions and minimal practical work noted in previous chapters. The distribution of objectives as based on Bloom's Taxonomy (Chapter 1) shows a predominance (about 56%) of low order objectives in the syllabus. Another dimension of the elusiveness of objectives is in the observation that some teachers found them to be restrictive:

Sometimes they force one to leave things hanging. For instance, in Reproduction at first year, it goes as far as drawing of the male and the female sex cells. In second year, it goes to mating and fertilisation, which process is unnecessary.

(Gar, Field notes, File 10)

One other teacher corroborated the view that where objectives are described in functional and prescriptive terms it is possible to infer some teaching behaviours which were consistent with their attainment. Examples are of teachers who started teaching with definitions of concept (e.g., density, mass, force) and who then progressed rapidly through the unit as in condensed lessons.

The objectives also led to non-uniformity in content coverage within and possibly across schools.

One teacher noted:

The syllabus is again not clear like on this topic, they want us too talk about heat transfer, and application and would say 'e.g. solar heating panel, the cooling system of the car, and then the vacuum flask'. So I do not know whether to take vacuum flask alone or all the three. Sometimes they are just too vague. When dealing with parts of the ear, the eye - they do not tell us where to stop! ... if you are two in a school, you end up teaching to different extends ... so we are teaching different things to pupils at the same level of education.

(Bai, Interview, File 11)

Comments like this demonstrated possible challenges to teachers' skills in devising appropriate teaching schemes and strategies. There prevailed a low ability to interpret the curriculum as a whole.

Classroom observations supported the teacher's views. It was observed that topics in Biology such as, Reproduction, Digestive System, Circulatory System and the Eye were extensively covered as teachers by their own admission could not determine where to stop. The observation was also corroborated by a circular from the In-service Officer to schools, announcing a workshop on the 11th October 1996, in which one of the agenda items was "*suggestions on how much to cover in each science module (for Form 1 and Form 2)*" (see section on workshops in the next chapter). Furthermore, as one teacher noted, some topics were taught only once in the syllabus so a lot had to be done at the one time. At the other extreme, the Physical science components (Physics and Chemistry) were covered to a lesser extent as some teachers said they found them 'challenging to teach'.

However, one teacher claimed to give objectives a broad interpretation, but, like other teachers, worked towards realising a set of objectives which was the main goal. This became apparent when the teacher was asked about the criteria used in choosing seven questions for a class activity on Food Storage and Preservation. She said:

I think the number does not matter but I was looking at the objectives and choosing questions such that they matched and fulfilled a particular set of objectives ... I get them from the syllabus ... The thing is, I believe if there is an objective you do not have to take it like it's a question you have to answer with just one answer. So, I know that if it is an objective, we have to be broad and that kind of thing and pupils will get knowledge relating to the objective but without pupils knowing specifically what the objective was. I mean, they are going to gain more from the discussion ... Achieving the objectives in the syllabus was the main goal, though there might be my goals like things I want them to know.

(Moa, Interview, File 12)

Teachers' concerns with instructional objectives might also be products of change from the past curriculum, which was *conventional* as content and associated activities were specified and teaching objectives were developed by individual teachers, to the current one for which instructional objectives are given but without Teachers' Guides. Against this background, it was not surprising that some instructional objectives were found to be closed, while others were seen to be open-ended such that the intent of curriculum reformers failed to reach the curriculum users. It would appear the objectives alone failed to be an effective way of guiding the implementation of the curriculum.

7.1.2 The '*cyclic*' nature of the syllabus

The foreword to the syllabus does not contain the terms *cyclic* and *spiral* to capture the format in which it was presented. It is only stated that "the syllabus is organised into ten broad themes called modules. The modules are introduced in Form 1 or 2 and further developed in latter years" (Ministry of Education, 1995a, p. i). However, the two terms were widely and interchangeably used by teachers to describe the format. Chalebgwa *et al.* (1996, introduction) also characterised the syllabus as 'spiral'. Whether the use of terms *cyclic* and *spiral* was an accurate depiction of the nature of the syllabus shall not be undertaken, but the terms are used in this work as they represent what teachers made of the curriculum. Two sub-themes relating to the curriculum were noted. They are: a) some teachers felt the spiral nature of the curriculum influenced their practice and, b) others felt it had no impact or, if it had any, it was not perceivable to them.

Teachers who said the spiral curriculum influenced their practice justified their claims in terms of extensive reviews of previous material in lessons and done in the form of question and answer sessions at the beginning of science lessons (see Chapter 5). Here, teachers' perspectives showed that their understanding of the nature of the curriculum and how that influenced its implementation was fraught with difficulties. For instance, on being asked how links between related modules in the syllabus were made, one teacher replied:

I find it very easy to use pupils previous knowledge. What I do is ask them to revise previous material and ask them a few questions at the beginning of the lesson ... Making room for future conceptual development is also easy. For instance, instead of stone, I put a wooden block which floated in water. In future, this observation could be helpful in dealing with friction ...

(Gup, Interview, File 13)

Another said:

... science concepts are linked to each other in various ways. So, everything is natural and falls squarely in place when and where necessary. I don't have to consciously promote that link ... I ask questions at the beginning of every lesson just to remind students of what we did previously ...

(Rak, Interview, File 1)

This interviewee's comments are based on the assumption that the syllabus (and curriculum) was spiral. The modules of a given topic are developed in various units without there being a clear link to how they related to each other. This makes it questionable whether the principle was built into the syllabus. It might, therefore, transpire that the curriculum is not what teachers thought it was. For some teachers what mattered was the topic at hand and not how it related to others to be covered in the future:

... I am not sure if I have taught with future topics in mind. But if I teach a new topic, I always look at it and relate it to the previous ones as well as to the real lives of the situation ... I think when you teach, it is easier during the course to relate the topic to the previous one than the future one! .

(Thu, Interview, File 13)

However, with almost all teachers being trained to be dual subject teachers, only one teacher out of the 26 voiced his resentment at teaching science when questioned on their understanding of the curriculum. The following dialogue is incisive:

Researcher: You said the curriculum is spiral. What do you mean by that?

Respondent: Hey, this one is really tough, I have asked this to Mr Y to help me figure it out. My real major is mathematics but I have been forced to teach science because there were no science teachers around ... I know it keeps on building just like that - and what you teach is just the basics and those basics you just build from there ...

Researcher: How then does your view of the curriculum influence your teaching?

Respondent: I do not know really ... sometimes when I do write questions or prepare for a lesson, I never think about these things - I just set without ever looking into the nature of the curriculum as such. By just looking at the questions I just say, 'oh no', they might have not understood this so let me put it down and check if they have understood ...

(Kea, Interview, File 5)

As noted in the field notes, another teacher said *'he was yet to think about it'*, that is, about the nature of the curriculum and how it influenced his practice.

Clearly, teachers held different perceptions of the curriculum. Some were simplistic, like the teacher (cited above) who claimed to swap a stone for a wooden block as he felt that might be useful in teaching friction later. Other teachers felt that creating room for future conceptual development was built into the syllabus itself. Others said the syllabus objectives set the scope of content coverage at any level (i.e., Form 1, 2 and 3). This also served as a mechanism for regulating concept development in the future. At the extreme end were those who had not thought about the nature of the curriculum. Generally, it seemed that teachers had a minimal

understanding and appreciation of the concept of spiral curriculum both in practice and in principle. For instance, examples of pupils being given restricted definitions of concepts; repetition of concepts; pupils' explanations of filtration framed in terms of an experiment done previously, and finally, of pupils' underdeveloped manipulative and scientific skills, may justify my claim. The issue of *forgetfulness* of pupils and of their need to *remember or recall* material from previous modules has been discussed in the previous chapter. All the evidence invariably pointed to difficulties at the meeting point of the 'old' and 'new' concepts in teaching, which may be largely a consequence of teachers' failure to appreciate the implications of curriculum to their practice.

Further evidence of problems was available. Classroom observation showed that syllabus coverage was fragmented, with the focus being on seeing modules as discrete and isolated units of the syllabus rather than as parts of a whole. Actually, it is not clear from the syllabus how continuity between modules on a particular topic was promoted and fostered. Also, teaching had no in-built long-term focus and objectives such that pupils might not have benefited from the structuring of the syllabus. In extreme cases, there were teachers who apparently did not see the need for content coverage as regulated by the syllabus. This is captured in the following citation drawn from an interview:

Researcher: Now let us come to the content issues. Some of the properties of carbon dioxide given to the students were that: 1) very reactive materials such as magnesium burn in Carbon dioxide to form magnesium oxide and carbon; 2) it reacts with alkalis to form carbonates ... which I thought this is the sort of stuff they will meet at senior secondary school level. What is your view about that?

Respondent: I think they are going to meet the stuff next year in Form 3 syllabus. There is a topic on Acids and Bases so they are going to meet it there ...

Researcher: So, what was the purpose of raising the subject matter this time?

Respondent: It was part of the provision such that next time when we meet the topic I just remind them about what we discussed.

Researcher: So what do you expect pupils them to do with such high level knowledge?

Respondent: For that one, it is for them to memorise it as it will be explained later...

(Kea, Interview, File 5)

This seems to explain the situation in which some lessons appeared empty and directionless without there being anything new and substantive taught to pupils. This happened because teachers had previously used more materials than necessary so that the future treatment of the topic was via repetition and recall. The above citation should also be seen against a background of observations as noted in Chapter 6 that some teachers had completed modules of the syllabus for

a particular term four to six weeks in advance of its end, irrespective of whether there were end-of-term school-based examinations. It is also imperative that teaching should be seen in the context of teachers' complaints about time and amount of syllabus content. The overall impression from the teachers' understanding of the curriculum and classroom observations suggested that while teachers were using the same syllabus they were either getting diverse messages from it or it was not sufficiently tight in scope to control or restrict teaching.

Despite the evidence regarding some difficulties with understanding the curriculum, almost all teachers stated that they found it easy to implement. Viewing this against teachers' views on curriculum, it would appear that some conceptual understanding of the curriculum existed but that the modalities of the curriculum implementation had not been an important consideration. One observation was that there were no distinct cases in the actual course of concept development which could exemplify teachers' overt and conscious use of knowledge from past modules as a source of direction in teaching. As some teachers had remarked, there prevailed in some a perception that links between the old and the new did not have to be consciously promoted: they were seen as axiomatic, natural and self-evident. Some extrapolated on the position by alleging that, after all, they were built into the curriculum. Overall, the meaning of the curriculum remained elusive both in the syllabus document and in teaching. The interpretation and operationalisation of the instructional objectives was a major impediment to curriculum implementation. The data shows that some teachers also had difficulties with the subject matter of the curriculum. This is discussed next.

7.1.3 Syllabus subject matter

Apart from the instructional objectives, science content and everyday experiences, all of which are key components of the syllabus, have been observed to pose challenges to teachers. Several examples drawn both from classroom observations and interviews are produced below as evidence.

7.1.3.1 Science content

Classroom observation showed that some teachers experienced conceptual difficulties in teaching some parts of the science syllabus. In some cases the problems were masked by reliance on textbooks during teaching. Examples include coverage of topics on the Nitrogen Cycle, Atomic Structure and Force wherein the teachers had failed to introduce the topic but gave elaborate notes from the textbooks. In other cases, the difficulties were apparent in teaching. For instance, in a lesson on Photosynthesis, one pupil sought clarification on the position of sunlight and chlorophyll in a word equation; specifically, why the two were not on either side of the equation (i.e., as reactants or products). Consistent with his previous view that they were *catalysts*, the word *helpers* was used although they were mistaken views of their roles in the process. He had

displayed unwavering consistency and commitment to the interpretation throughout the lesson.

Upon being interviewed, the teacher said:

Actually, there I was trying to clarify between reactants ... (brief silence) I wanted to show them that they should not make a mistake of saying they are reactants because in this case I wanted them to err ... get it clear that reactants are the ones which combine and give products ... I wanted to show them that chlorophyll and sunlight are used just like carbon dioxide and water. However, carbon dioxide and water are combined and others aid the combination. So generally we say both of them are used by the plant ... They are a prerequisite (to a reaction). .. I got entangled when I came to reactants. There I had to distinguish between reactants and products. ...

(Mau, Interview, File 9)

Two further illustrations highlighting similar difficulties with concept development are given. In one case, a teacher had been consistent throughout his lesson and during interviews in his view that filtration of muddy water gave *clear water* when he had actually got a filtrate which was ginger to light brownish in colour in a class experiment. In an interview, later he held the same perception, and said that his pupils would not know that filtering pond water using a cloth as a filter results in:

... reasonably clear water without tadpoles and all those unwanted items ...

(Pon, Interview, File 6)

He then lamented what he perceived to be *unfortunate* as he said that rivers always carried *clear water*, so his pupils might not be urged to deploy their knowledge on filtration. From the illustrations he provided it became apparent that the word *clear* was used in reference to the relative absence of insoluble impurities and not in terms of colour.

A second illustration is drawn from three successive lessons on Drugs taught by one teacher. His definition of drug referred to illicit drugs or narcotics, while medicinal substances were referred to as medicine. The teaching was such that the two areas were presented as though they were independent and not interrelated, despite the fact that the two terms are used interchangeably both in science and in everyday life. Drug addiction was similarly treated with respect to illicit drugs while addiction to medicinal substances was not covered. Teacher's explanation of addiction to smoking, focused exclusively on nicotine, thereby marginalising the very context through which the nicotine was administered. Nonetheless, the examples demonstrated the possibility of teachers giving pupils information which was partially correct and, in some cases, entrenched misconceptions or even mistaken views of phenomena. Appendix 9 contains further examples of teachers' conceptual difficulties. As explained later, teachers' confidence in teaching science was so low that it was advisable not to talk about their own problems. Nonetheless, as shown in Chapter 6 on concept development, teachers' difficulties were also evident in the incorporation of pupils' experiences into teaching. Teachers' views on the issue are presented below.

7.1.3.2 Views' on everyday experiences

In Chapters 5 and 6 examples of instances in which pupils made experience-based contributions in science lessons were presented. These are not be repeated here. Instead, the focus is on what teachers made of such contributions and the experiences in general.

The experiences of pupils were variously recognised by teachers though they were not fully explored or exploited in concept development. Evidence for this came in different forms. In one case, a teacher who sought pupils' knowledge on First Aid (Chapter 6) after lecturing, said:

I wanted them to realise that there is science in the home and in school. So, even though we do things differently but somewhere they link together ... I know they have an experience ... For the First Aid techniques at home there are no explanations on how they work but at the end we can realise that even though there is no explanation but in the end they help.

(Obo, Interview, File 1)

It is noteworthy that teachers distinguish between science and non-science. Another teacher made a similar distinction and essentially saw pupils' experiences as a hindrance to teaching. He said that pupils :

... have certain fixed ideas which I think are related to upbringing and it is very difficult to make them see that it is not scientific ... They find it difficult to relate it (i.e., formal science) to reality: it is something in the book and done in school. It is not something that relates to home. That is how I see it. To learn it, it does not stay because it is something artificial, not related to reality which can become part of them.

(Dus, Interview, File 6)

This teacher seemed to have adopted a radical position which sought to replace pupils' non-scientific or cosmological views with formal scientific knowledge. He does not seem to recognise that science is based on consensual perceptions. The approach would naturally create a state of tension in knowledge acquisition as it sought to replace aspects of the wider culture which pupils had acquired over time with scientific explanations and related conceptions of reality. For some teachers, pupils' experiences were used rather infrequently, and to expedite teaching:

... I do not use that a lot ... whenever there is a problem, like when I introduce something to them ... if I realise that they are lost, I just come up with a real-life situation, taking them home a bit so that they can think of what happens in home and try to relate that to what I am going to teach.

(Kea, Interview, File 5)

One teacher who had been observed teaching one class on Digestion in three different lessons had not integrated his own or pupils' experiences into concept development. He explained the situation thus:

Sometimes it is just overlooking that aspect. It is unfortunate that you came in at the time when I did not have any student experience from pupils' side or mine!

(Pon, Interview, File 6)

This shows the curriculum to be a collection of science concepts weakly related to each other as well as to the pupil's environment. In terms of curriculum implementation, it is apparent that the philosophy of the curriculum failed to guide curriculum implementation. Generally, there was strong evidence suggesting weak incorporation of pupils' experiences and of everyday examples into teaching. The experiences which frequently came in at the concept application stage seemed to have a lower teaching priority than did formal science concepts.

The examples used in Chapter 6 to illustrate how one teacher was alienated from his pupils because he sought only science-based explanations illustrated problems at the contact point of science and *non-science* material. More problems of teachers' alienation from pupils are presented here. They display two aspects. One is that phenomena common to both teachers and pupils is understood and interpreted differently in science learning by the two groups. The second aspect is that teachers' understanding of the environment and of the application of science to it was restricted in most cases such that they could not effectively use pupils' contributions in teaching. The two aspects are illustrated below.

Teachers sometimes encountered difficulties with experiences-based examples contributed by pupils. Some examples of the phenomenon have been given in Chapter 6. More examples include, conceptual or knowledge conflicts which sometimes arose from different interpretations of terms. In one class, pupils said there were *rivers* in their locality which the teacher denied, adding that rivers would always have water flowing in them. This explanation was and is at variance with typical conceptions of the term in Botswana: rivers, streams and the like are mostly ephemeral. It would seem that pupils were left doubtful of the teacher's conception and interpretation of a *river* both as a concept and as a physical structure. In another instance, a teacher's lack of acquaintance with the environment became apparent in a lesson on the Ecosystem. The teacher expressed her surprise when pupils said that frogs ate insects. By her own admission, she also thought snakes would kill but not eat frogs. This was problematic as the class by then attempted to construct a food chain comprising different living organisms in their environment. In another case, a pupil stated that *drugs* available off-prescription could be obtained from a butchery. The answer was rejected by the teacher despite some butcheries in the village being multi-purpose businesses, depending on their trading license. When interviewed about the incident, the teacher said:

Well, I got the impression that he was kidding me!

(Tem, Interview, File 10)

The significance of the illustrations to the implementation of the curriculum is that the teachers sometimes appeared unprepared to incorporate examples of everyday applications of concept and pupils' experiences into science teaching and learning. To teachers science has remained esoteric and they have not yet made meaningful connections between it and the environment. This is illustrated below.

In one case, a teacher rejected what appeared to be valid contributions from pupils. This happened in a class exercise in which one of the questions required pupils to "list methods of storing and preserving food". A pupil said: "*we can dry uncooked meat*", which is the norm in rural country side. The teacher responded: "*That kills micro-organisms and is not storage of meat!*". However, the teacher later contradicted herself, though that passed undetected by both the teacher and pupils. She gave a hypothetical illustration of dry and boiled rice requiring pupils to state which of the two would rot over time. Pupils said the boiled rice would rot because of its moisture content. The teacher agreed but did not reconcile this with her earlier rejection of drying meat as a way of preparing it for storage. Another pupil's contribution seemed to be a wild guess: "*We can preserve sorghum by putting it in a refrigerator*". The class roared with laughter at this, and the teacher seemingly found it to be a ridiculous proposition. But it was not debated. While it could be non-economical, a refrigerator can have temperature(s) low enough to thwart the growth of moulds and fungi. This preserves the sorghum without the use of chemicals. In a subsequent interview, the teacher was asked to explain her rejection of the two answers. She said:

Storing and preserving are two different things. ... the pupil was talking about storage though that question falls under preserving and that is why I had difficulty with the two responses ... (after asking for clarification and interrelationships between the two terms, she enquired) So in talking to these students, you should not distinguish between the two?

(Moa, Interview, File 12)

It was apparent from the interview that the teacher had conceptual difficulties with the two terms, since they were seen as clear, distinct and non-interrelated concepts.

In retrospect, pupils' experience-based contributions to learning by way of asking questions (Chapter 5) and of responding to those from teachers (Chapter 6) have shown teachers playing 'expert' by supplying science-based explanations. Sometimes teachers were dismissive of the contributions in various ways, including being arrogant to learners. This is illustrated by the cases of photosynthesis in Chapter 5 and that on components of air in Chapter 6. Playing expert and being arrogant is the behaviour displayed by teachers who felt threatened by situations in which they had to relate science to out of school experiences. As some cases show, teachers had little

knowledge of applications of science and were limited in their skills and strategies of evaluating the situations and of meaningfully relating them to science. This problem worked against the implementation of the science curriculum.

Overall, the available evidence pointed to weak understanding by teachers of the ways and purposes for integrating examples from the environment and from pupils' experiences into the teaching of science. However, the syllabus was not definitive, was non-committal, and lacked acuity on the matter. It states:

The content has been selected from the students' immediate environment to facilitate understanding and ease of transfer of skills and knowledge to real life situations. What happens in the classroom must lead to informed and empowered citizens who can meet the challenges of the 21st century. We believe the syllabus will assist in this regard.

(Ministry of Education, 1995a, Foreword)

The rhetoric is not reflected in the various modules of the syllabus, making it more science content-based and hardly context-based: this is probably what was reflected in concept development. Furthermore, the Introduction to the syllabus contained the following 'pedagogical assumptions' underlying its implementation:

In teaching the syllabus, it should be realised that when children come to school, they come not with blank minds, but with some knowledge, skills, attitudes and beliefs. Some of the experiences may become useful or inhibitive during the teaching process, and so teachers have to be aware of these earlier experiences to more effectively communicate understanding through recognising individual abilities, interests and needs ... Science plays a central role in society by helping children gain an understanding of the scientific and technical aspects of the society in which they live.

(Ministry of Education, 1995a, p. i)

It is apparent that the centrality of pupils' experiences to science teaching was recognised in the syllabus document, although no pretence was made as to how teachers should, first, recognise them (i.e., experiences); second, how they should or could be infused into the learning of science. But, as evidence from classroom observations and interviews with teachers showed, teachers were not adequately prepared to apply science to pupils' experiences and everyday examples. It would appear it was assumed that teachers, being graduates of colleges which are specifically for producing teachers in CJSS, were flexible, adaptive and suitably qualified for the job. Furthermore, the Ministry has probably underestimated the demands of applying science to examples supplied by pupils and those from the environment in general.

As this section documents, it is unsettling that teachers had conceptual problems with pure science content. The point is that while instructional objectives posed a challenge to implementation, conceptual problems posed a much more fundamental and perennial problem as

did the fact that science content and applications to the environment were not seen to form one entity. Teaching content only was possible without incorporating learners experiences. The situation pointed to the need to find out about the confidence of teachers in implementing the curriculum.

7.2.0 Teachers' Confidence in Teaching

Aspects of teachers' confidence in curriculum implementation were sought through interviews. Generally, there was some confusion about the curriculum and its implementation. For instance, one teacher said:

The thing is, I am confused. I do not know if I am doing the right or wrong thing. I am just trying my best to do what I can ...

(Rak, Interview, File 7)

Another said,

Myself, I can't say I am doing well in science. I'm doing my best because that is not my major really ... I'm satisfied with biology section and a bit of physics topics. The chemistry part - I have problems with it - I have to read a lot when it comes to them (i.e., chemistry topics).

(Kea, Interview, File 5)

Another teacher seemed to lack confidence in what he did in implementing the new curriculum. He said:

It is too early to ask me that question. It is a year and half since I started teaching the syllabus. What I look forward to is workshops in a more relevant manner ... we all know what we ought to do but at the moment what we are doing is haphazard - we will be lucky to pass pupils...

(Dus, Interview, File 6)

A definitive position linking teachers' teaching strategies to their confidence levels cannot be arrived at because, in practice, teachers appeared confident and had reasons to justify adoption of a particular teaching approach. Nonetheless, with teachers having acknowledged their problems with the curriculum, and with the availability of evidence corroborating this, a decision was made not to interview teachers on their respective problems with content. This was decided for two reasons. One was that it was important to maintain rapport which had been established with teachers. Second, interviewing in areas in which teachers seemed weak might have shaken their confidence and self-esteem in teaching. It was, therefore, necessary that data for the latter areas be collected mainly by way of classroom observations.

However, the instances are not discussed here because they seem to fall outside the scope of this work although they, too, were a factor in the implementation of the curriculum. Some examples

of the problems are documented in Appendix 9. Table 7.1 shows the distribution by general category of some of the incidents.

While it is not shown how many teachers were involved, the Table shows that in nearly as many cases teachers propagated misconceptions as in instances of low mastery of subject matter. This should be seen against the predominance of lecturing and question and answer teaching sessions. Teachers' acceptance of incorrect answers from pupils is puzzling and serves to magnify the complexities of problems. Interestingly, as discovered in one case a wrong answer supplied by a pupil was drawn from teacher-made notes. The pupil said freezing water was a water purification technique. Quite clearly there were other problems in the implementation of the curriculum which were independent of the curriculum itself. A further illustration of the issue is found in teachers' perceptions of the pupils.

	Instance	Frequency
1.	Teacher accepts discordant/ incorrect answer	6
2.	Teachers' low subject matter apparent	22
3.	Teacher propagated misconception	19

Table 7.1 Distribution by Category of Teachers' Conceptual Difficulties

7.3.0 Teachers' Perceptions of Pupils

Following from classroom observations and from the evidence that teachers involved pupils least in concept development, teachers' explanations displayed their dissatisfaction with pupils from primary schools. In exploring the concerns, some information on procedures for enrolment at junior secondary level and teachers' views on pupils are presented.

Primary School leaving Examinations (PSLE) are sat by pupils at the end of their seven-year primary school education and en-route to CJSS. Enrolments in CJSS have been characterised as, from a point of government policy and practice of transferring pupils from primary to junior secondary school, consisting of pupils of mixed abilities. Teachers nonetheless used a shorter title: mixed ability. The mixed ability groups comprised pupils with different overall achievement grades in the PSLE, ranked on a nominal scale with 'A' being first class and, at the extreme end, 'D' and generally interpreted as fail. Pupils falling into the latter group are sometimes called slow learners. The automatic promotion from primary to CJSS of pupils irrespective of their achievement has been a source of concern amongst teachers. The ability of pupils to learn science is thus assumed but not established at the time of transfer. Subsequently, one theme that emerged

from interviews with teachers is their concern with pupils' achievement at PSLE and not their abilities *per se*. The evidence for the assertion is presented in the discussion below.

Teachers' perceptions of their pupils showed concern with the grade 'D' pupil. One teacher said:

The only thing of course is that science is a very important subject ... the type of some pupils we receive from primary schools is just too poor and need special education. They should not be included in mainstream education because for them to come here, they are even made more frustrated than they would have been if left out because they are made to expect nothing in life: they come here and go out empty handed.

(Rak, Interview, File 7)

One teacher corroborated the view:

Why can't those poor achievers at primary school level remain there because they come here and do not benefit a thing? Sometimes we feel we are delaying those who are bright. Another thing is we need those worksheets which we previously had so that when we guide them they know where to write.

(Bai, Interview, File 11)

One teacher felt that attempts at realising the goals of the curriculum which among others sought to prepare the pupils for adult life and the world of work were unrealistic with the type of pupils in his class:

... the students who come here with D grade, who cannot even understand and communicate, are doomed. Again those who do understand still have no chance ... because at this point I do not think they know much, they cannot even get a job. From here they are going to do jobs for which their science will not be used.

(Mau, Interview, File 9)

There was also a generally perceived mismatch between pupils and curriculum:

... the quality of the input from primary schools is low ... the syllabus is no doubt a long tale. Here and there we have pupils who cannot write their names, or even speak their names and to them, it is a conflict, a challenge to the teacher to handle such a long syllabus. When we look at the government, it aims high, and we see that every community would like to see its 'kids' know more and more. It is a good thing. But currently, it is not pragmatic to have this lengthy syllabus to the sample which we receive ... I see it as challenge to a teacher - transformation of student from low to high level ... it is a tough situation.

(Mru, Interview, File 7)

The above appeared to be made even more difficult by the average class size of about 40 pupils, which tended to affect the quality of teaching. However, some schools had action plans for remedial teaching classes, but ironically not for low achievers in particular:

... I would not say I have a proper arrangement to cater for them (Form 1s) unlike in Form 2 where we have remedial classes. For these ones we do not have much time ... it is not easy because the class is big again - we have a class of 40. Like in practical ... it is not easy to attend to each student satisfactorily in a double period in that first you have to deliver the content and thereafter you have to assess.

(Mau, Interview, File 9)

It appears that the individuality and needs of pupils were not used in the teaching of science. The fact that remedial teaching was not selective demonstrates three points. One is that normal teaching was akin to teaching for "teaching sake" and was without specified focus groups. Secondly, there were no pupil performance monitoring devices built into teaching strategies such that teachers had no clue of pupils' understanding of concepts and their areas of difficulty. The third aspect of the problem is that school enrolments and classroom composition were sensitive political issues. Streaming by ability was outlawed and mixed ability teaching was used and promoted to avoid outright discrimination of pupils in class. Remedial teaching for weak students only would have contradicted this position and thus exposed the weaknesses of the education system. Remedial teaching was thus for all pupils.

Nonetheless, one teacher observed that the schooling system denigrated or failed low achievers by not affording them the necessary support:

Most of them I sometimes do not want to call it heritage or that it is hereditary. Some could have been shy, could not have been protected when they were in the system - they could not be better off comprehensive-wise; their communication could not be that good such that may be if we were allowed ... if it were possible that they could speak in Setswana we might get better responses. At the same time, if like I was saying about protection, if other pupils had been allowed to laugh at them, and no action is taken against them, then the child would feel that - OK let those who know better do the answering, I will just be part of it. Most of them like I'm saying, you will find that the system takes on board D students whom some of them cannot even copy the notes correctly from the board ... they tend to mess everything up even clear cut situations where they apply a formula, they do things differently.

(Pon, Interview, File 6)

Three such pupils were identified in three different schools. The case of pupils who copied notes with mistakes from each other has already been reported in Chapter 5. In the other two cases, pupils had to draw diagrams in their notebooks. In one case, a teacher unfolded a chart with a mammalian heart for pupils to draw as a class activity. On walking around the class I noticed one pupil who had not begun the activity. Her reason was that she found the drawing difficult. In paging through her book, I noted that she had several diagrams which she said were traced from textbooks, while others were drawn for her by friends. She said she still expected her friends to assist with that day's activity. The teacher later realised that she was not working, but took no

action. In another case, a pupil traced parts of a diagram from a book, claiming that she too had difficulty with making free-hand drawings.

The view that teachers 'tend to assess a child somewhat narrowly from the classroom viewpoint' could not be more correct. The negative views that teachers have of pupils fit well with the teaching methods used in the schools. Nonetheless, as shown in Chapter 5, pupils made contributions to learning and hence demonstrated alertness to what was happening in the classrooms. What also became apparent during classroom observations was that while teachers were able to realise that pupils appeared disinterested, they (teachers) did not seek to turn around the situation. The teaching continued without a change in strategy. Numerous instances illustrated the problem. In one class, a teacher lectured at pupils, with occasional questions. Some pupils were seemingly attentive, while others were aloof. The teacher noticed one 'sleepy' pupil and said:

... Dithapelo, say something, you look sleepy and soon you will be snoring! ...

(Tem, Observation , File 10)

In another case, one teacher said:

Hey you!, don't you want to talk to me or are you hungry? Haven't you had a slab of bread and tea at tea-break?

(Obo, Observation, File 7)

The problem, according to some teachers, was the pupils. One said:

Sometimes it frustrates when pupils are there and just sitting passively not doing anything, you ask them questions and you try to explain everything and do not respond and are just seated there - then this frustrates a lot. And when it comes to these topics which it seems they are not OK ... they are just dormant and I'm not just OK with those pupils. I sometimes feel I am not doing good to these students ... some students are not supposed to be here because of their academic performance. They did badly at primary school may be they are just saying how can this person talk like this (i.e., bemused) ... really it frustrates.

(Kea, Interview, File 5)

There is more evidence that the problems apparent in teaching deluded teachers themselves, and concern with academic performance rather than with making pupils part of teaching, were prevalent in some schools where remedial teaching had been planned. One teacher in such a school said:

Though I tried to involve them, there are some pupils who are listening but they do not understand ... there are some pupils who were not involved ... They lag behind. If I explain they don't really get what I am

saying ... they are left behind and they do not even know what we are talking about ... We (at school) are planning on remedial teaching to be done outside regular teaching hours - that is in the afternoon ... but we are starting with mathematics and we will come to science later.

(Bai, Interview, File 11)

However, two teachers' views of pupils summed up the impact that pupils had in the implementation of the curriculum. One said:

... the pupils themselves are inactive and not initiative-taking. They are simply not inspiring. Whether you say rubbish or not, they remain passive though it is the pupils who should drive the teacher to do more or less meaningful teaching ...

(Gar, Discussion, File 10)

Another said:

... they are not stupid but lack interest and motivation ...

(Gil, Interview, File 10)

On the basis of evidence it seems justifiable to state that the abilities of pupils to study the syllabus was not explored, identified or exploited. This further weakened the effectiveness of teaching as well as the implementation of the curriculum. It seems that teaching was inspired by and based on achievement and not on pupils' abilities. From the data, it appears that it was either that the teachers had expected pupils to have motivation from within (i.e., intrinsic), or from the classroom tasks themselves (i.e., extrinsic). For instance, there were very few cases in which teachers showed appreciation of pupils' contribution: supplying a correct answer to questions was taken to be an external reward, a form of motivation. On the other hand, the low pupil involvement in class, especially with regard to giving their own examples, could intimate that pupils were expected to be intrinsically motivated.

Nonetheless, some teachers decried what they felt was the failure of the Ministry to develop a curriculum which reflected the abilities of the target groups. A written account of one of my discussions with one such teacher stated:

Miss K has observed that the ministry advocates mixed ability teaching which, she says, calls for the differentiation between pupils and therefore differences in teaching of students in the same class. However, the syllabus itself does not show how this should be done; teachers have difficulty in knowing how to do the differentiation, in particular, what should be done to teach 'the same topic and to the same objective' to pupils of diverse abilities.

(Kal, Discussion, File 11)

Another dissatisfaction with the syllabus was that it did not offer guidance on teaching at different levels (i.e., Form 1, 2, or 3), supporting the view that induction of new pupils to learning science was probably inappropriate. Form 1 was invariably seen as the most challenging group to teach although they received similar treatment to Form 2s and 3s. Teachers suggested this uniformity in teaching was occasioned by the fact that the syllabus did not distinguish between teaching at the three levels. Pupils' heavy dependence on teachers, lack of initiative and confidence in science in general (Chapters 5 and 6), and docility and low motivation levels characterised teaching at all levels.

Regarding the question of teachers' perceptions of pupils' abilities and of how that impinged on practice, it appears that some teachers found pupils hard to deal with. In line with Delamont and Galton's (1986) notion of making the *familiar strange*, four expressions by teachers embodied the difficulty. One teacher said that his pupils "*wanted to do things their own way*", two others complained that *pupils learned to forget*, while the other wished on having brighter pupils when he said: "*there are very few who are intelligent: children who can do as you want them to as their teacher*". Another said: "*they do not know why they are in school! This one is general observation*". Such explanations point to subtle elements of desperation, insecurity, deeper sense of loss over pupils and, inevitably, control over their knowledge acquisition. Quite clearly, and beyond the institutionalised power teachers had over pupils, power-relationships at teacher-pupil interface at micro-level in the classroom meant that teachers and pupils did not communicate well with each other. The disparities manifest themselves through the means, modalities, or pathways to knowledge acquisition as teacher and pupils might have not necessarily subscribed to the same view of learning.

Instances have already been given in which teaching strategies failed, for instance, in question and answer sessions, in class practicals and in lecturing. But the fact that pupils were said to be forgetful was more than just a view or an explanation, but was equally a manifestation of a possible state of tension or conflict in modes and purposes of learning. On the other hand, teachers' subtle sense of desperation might reflect an identity crisis over their affiliation with pupils, particularly in light of the fact that the culture of learning that teachers enacted, maintained and attempted to sustain throughout the years had not been working well. But then evidence demonstrated that, such a culture was amorphous, superfluous and perpetuated by teachers who consequently wanted pupils to be compliant because non-compliance necessitated change in teaching approaches and in the whole culture of teaching and learning science. This was yet another area which teachers found difficult to negotiate.

7.4.0 Summary

In this chapter several important aspects of implementation of the curriculum have been discussed. Teachers were generally concerned with uniformity and conformity in implementing the curriculum. Contrary to the teachers' anticipation, the syllabus was simply not effective as a tool for guiding practice. Furthermore, concerns with *realising* the specific objectives of individual modules in the syllabus was the driving force behind teaching despite the teachers' concern about their (i.e., specific objectives) low level of explicitness. This development should be viewed against the fact that there were no Teachers' Guides or purpose-made textbooks which could offer alternative ways of operationalising the objectives.

This lack of exposition on curriculum by the Ministry did not ensure preservation of the philosophy on which the curriculum was founded and intended to promulgate upon implementation. This was illustrated by various challenges which teachers experienced in the use of the curriculum. For instance, where teachers attempted to bring in examples of applications of science in everyday life, or when pupils made contributions drawn from their experience, there were often difficulties. Where attempted, teaching strategies seemed to lack plausibility, were contrived and short-lived for the discussion of the phenomenon to be of benefit to pupils. Therefore indications were that the curriculum paradigm which sought to incorporate everyday examples and experiences in teaching was lost through poorly resourced teaching.

The view that teachers' perceptions of their pupils achievements were a crucial element in the implementation of the curriculum put the whole process of implementation into its proper context and perspective: basic education. Throughout this and the previous chapters, it has been argued that it was unclear as to whom teaching targeted. While teachers were concerned with 'grade D' pupils, a more fundamental concern related to balancing the demands of access to Basic Education, maintenance of academic standards and the attendant demand of teaching a wide ability group. This was a major area of difficulty in the implementation of the curriculum.

However, the syllabus document and the curriculum as a whole have not focused on the area, resulting in teachers' high expectations of their pupils being dampened when they (pupils) did not seem to be the type suitable for the curriculum. And paradoxically, teachers were effectively a barrier sandwiched between the curriculum and the pupils. For, since the "student-advantage" was the ultimate aim of the curriculum change and strictly speaking, the same students could not be seen as obstacles unless they were being made scapegoats by teachers. Taken together, that has led to practices whose effectiveness and efficiency in the curriculum implementation are questionable. The overall impression that teachers' views create is that the curriculum was fraught with difficulties which seemed to originate in the development of the curriculum itself and the material support it had for its implementation

CHAPTER 8

INSTITUTIONAL FACTORS IN THE IMPLEMENTATION PROCESS

This last chapter on research findings aims to highlight *institutional* factors which had an impact on the implementation of the curriculum. The term 'institutional' here was used in the broad sense of seeing the implementation as being undertaken within the bounds of an educational establishment, encompassing schools and beyond. In so doing, the scope of the deliberations was restricted to those factors which teachers felt impinged variously on the implementation of the curriculum. So, there was no concern with the various structures that the Ministry of Education had (or proposed to) put in place to oversee dissemination and the subsequent implementation of the curriculum within schools.

Evidence gathered in the field showed that the institutional factors fell into three areas 1) resources for implementation; 2) organisational structures and leadership within schools; and 3) action by the Ministry. These aspects are discussed and illustrated through examples drawn from classroom observations, documents and interviews with teachers. The chapter is premised on the implications of the teachers' views that curriculum cannot be seen outside the context of the organisation and the administration of the education system. In other words, no curriculum is above the organisational and administrative structures within which it exists.

8.1.0 Resources for Curriculum Implementation

Apart from textbooks, time and laboratories were resources needed for implementation of the curriculum. The two resources are discussed below with respect to how each impacted on science teaching.

8.1.1 Time as a resource

Teachers' concern with the availability of time for teaching was a theme that surfaced repeatedly during interviews. Appendix 4 contains a sample of teacher's time-tables and explains the different systems in use in the schools in the study. Teachers expressed concern that there appeared to be more material in the syllabus than the available time would allow for teaching at a reasonable pace. This was raised in Chapter 5. However, classroom observations seemed to suggest that teachers had developed other strategies to address the problem. For instance, it was noted that the ideal teaching session terminated with a *conclusion* had been dispensed with in almost all lessons observed. Also, new activities, for instance starting a new topic or module; conducting an experiment, writing notes and written exercises, were often started with relatively little time left before a teaching session wound up. This made lessons open-ended as they overshot the formal time they were allocated in the timetable.

As indicated in Chapter 5, afternoon preparatory time which was meant for use by pupils was variously used by teachers to complete unfinished tasks that had been planned for teaching on a particular day. So, some teachers invariably saw the preparation times as extensions of their (teachers') time. It was noted, however, that pupils seemed to have accepted and sometimes consented to intrusions into their study time. For instance, an indirect form of consent was made when pupils alerted their teacher that they would not be available for writing notes as some other teacher, from a different subject discipline, had already booked the time.

However, the organisational context in which science was taught is also important for increased understanding of time as a resource. The context here refers to the position of science as part of a new and wider school curriculum phased in over a five-year period. Since the schools were in transition, workloads of science teachers increased due to increases in school intake without a corresponding increase in teachers. Coinciding with Phase 2 of the field-work (January 1998) all the schools in the study had a total of 18 streams (i.e., classes) with enrolments ranging from 622 to 777 pupils and, an average of 35 to 45 pupils per class (see Appendix 4). Individual science teachers' workloads were typically a minimum of 30 out of 40 lessons per week (75% teaching and 25% fallow) for those on a five-day time-table and, at most, 48 out of 56 lessons per week (86% teaching, and 14% fallow) for those on a seven-day time-table. These figures relate to when the schools were operating at full-capacity for the first time in 1998. The three year school curriculum was introduced in January 1996. The previous year's (i.e., 1997) loads were lower. Teachers were typically engaged 60 to 75% of school time as all schools had two-thirds of enrolments. The expansion in school enrolments from 12 to 18 streams in 1998 strained teachers which was corroborated by a number of incidents. Examples of the incidents are given below as illustrations.

In one case, a teacher said he could not be observed because he was not prepared to teach, although he did not give his reasons. Neither was he requested to. However, he turned up for his lesson to give his pupils some task to work on. In some cases, teaching activities were suggestive of a teacher's ill-preparedness to teach. In one case, a video on photosynthesis with material beyond the scope of the syllabus and pupils' understanding was used. As it became apparent that pupils lost interest in it, the teacher enquired: "*Are you getting anything?*" Pupils responded, en masse: "*No!*". The teacher then cued the video to a section on addiction to heroin, and the bell marking the end of the lesson rang. But quite clearly, the essence of the activity was questionable. Examples of a series of some failed experiments involving different teachers have already been given in previous chapters.

While it could not be concluded with certainty that such acts were warranted by the heavy loads, it is noteworthy that no school in the study had a Laboratory Technician, an Assistant or a Laboratory Orderly. No one thus assisted with the upkeep of storerooms, science laboratories, and

inventories. All these had to be done by teachers, including any preparations that were necessary for teaching. In addition to such duties, teachers had to expend their spare time (i.e., in afternoons outside teaching sessions) in running school clubs as well as participating in various committees and undertaking administrative tasks in their respective schools. These activities tended to overload some teachers but were part of their job and counted in performance appraisals and promotions of teachers. However, the extent to which the problem existed could not be documented. One teacher, whose lesson I had reckoned was a manifestation of lack of preparation said:

I have no time to prepare because of my workload - 30/40 (75%) periods, and there are sporting activities in the afternoons held every day of the week. I'm therefore occupied with other things during my spare time.

(Rak, Interview, File 1)

Examples of situations in which pupils drew diagrams from textbooks as homework were given in Chapter 5. As one teacher said, he did not have time to draw the diagram for use in teaching so pupils would use those in their textbooks for reference.

In one case, a teacher sat calmly on his table, possibly due to fatigue. In the meantime, his pupils copied notes projected on a screen from an Overhead Projector. He had earlier made the notes for another class of Form 3 pupils. His timetable showed that he had been teaching since the morning (first lesson in summer started at 07:10 a.m.) with only a 30-minute tea - break, half-way the school's daily session of 8 periods. Having taught a total of seven periods, and by then on the 8th and last period of the day which terminated at 1:00 p.m., he was most probably tired.

Clearly, time was an important commodity and factor in the implementation of the curriculum. What this section has shown is that time cannot be considered in isolation. It has to be seen in context in terms of the way in which its use is formally organised in schools and in terms of how it is dispensed with by individual teachers. So far, concerns raised by teachers are rooted in their practice and possibly reflected on time as a basis for some discrepancies noted between the real and the implemented curriculum. If teachers are committed 75-86% of their time, then lock-step teaching practices prevailed as well as other efficient ways of transmitting large quantities of content in a short space of time. For instance, lecturing and condensed lessons discussed in Chapters 5 and 6. Chapter 5 also showed cases in which teachers reluctantly repeated some practicals activities because of time. Practical activities were not given adequate time. In the next section the impact of laboratories on curriculum implementation is explored.

8.1.2 Science laboratories

Each of the eight schools had two science laboratories. The physical dimensions and layout of the laboratories have already been discussed in Chapter 5. What is important here is the fact that the laboratories, inclusive of furniture and fittings, were consistent with the philosophy of the previous curriculum offered between January 1986 to December 1995. The curriculum, together with CJSS themselves, formed a single package founded on the recommendations of the National Commission on Education of 1976. In brief, the preceding curriculum had embraced the use of low-cost material available from the environment (Ministry of Education, 1986; Nganunu, 1988). At one stage, in or around 1984 and in addressing shortage of apparatus in the schools, materials for the low cost ZIM-SCI kit (Kahn, 1986) were supplied to some schools in Botswana.

The important point here is that the laboratories as designed and developed by then were inconsistent with the nature and philosophy of the curriculum. In line with the use of low cost material, scanty provision of gas points, washing sinks and water points, and electrical outlets characterised the laboratories. Conversely, however, the new curriculum has not specified the pedagogic philosophy which guided its development; an observation which is perhaps supported by teachers' complaints about the laboratories. The evidence shows that teachers saw the layout of the laboratories as posing difficulties for the conduct of practical work. For instance, one teacher had to ask pupils in an experiment on photosynthesis (discussed in Chapter 6) to move back so that two pupils per group could undertake it, said:

I had to make them move back because the layout of the laboratory is such that they will be crowded. If they form a curve then they can all see. If they stand in a line they cannot all see the experiment. I found that it was much better if they move backwards.

(Mau, Interview, File 9)

Another said:

I just have to adapt myself to what is available, how the thing is set up. There is no point in me saying 'no it cannot work'. So I have to do my best with what is there but I know it is not the best. If I try something different, I may run into serious problems. For instance, I may use long hoses to bring the gas to the tables, but, I can't tell, someone may push the tube from that end and with the gas flowing, there might be an accident. So I just prefer to do it there ... This is very inadequate with about 6 gas burners for a class of 35 and all of them (burners) put on one side.

(Dus, Interview, File 6)

Finally, one said:

The syllabus was intended to be pupil-oriented ... Looking at a number of factors, we are unable to do so. Our labs are small, we have about 45 pupils in a class and if we divided them into groups of 5 individuals each, then there are 9 groups to work with. We have only 6 'working points' with Bunsen

burners, then we have to have 7-8 pupils per group and in that way not all the pupils will be participating, others will be spectators - we cannot develop skills under such conditions. We can develop skills properly and very well if pupils work individually - this also calls for more time. But there is already no time to prepare for the labs, preparation for teaching, even in marking pupils work.

(Rak, Interview, File 7)

While teachers were concerned with the low provision of Bunsen burners, nearly all science storerooms (except for the three new schools) where interviews and discussions on aspects of science teaching often took place, had large quantities of spirit burners. The latter were a legacy from the past curriculum and were first introduced into schools with the previous curriculum around 1986. At the time, the spirit burners were not only an alternative to, but also replaced Bunsen burners as a low cost option: gas points were provided for experiments which needed sustained and strong heating not possible with the spirit burners. Teachers nonetheless decried their inefficiency and hence their low economy on time. Incidentally, despite its small size and skewed location (put to one side of the laboratory) the teachers' desk, was a significant factor in conducting demonstrations apparently because it was complete with a gas tap, water tap, a porcelain sink and electrical power supply. It was more than a territorial base for teachers in the laboratory. Perhaps, it symbolised conditions and provisions which teachers identified with and which they felt articulated well with teaching the syllabus.

As it transpired from five of the schools which had been operational before the new curriculum was introduced in 1996, no new equipment was supplied to schools, save for replenishments of glassware and chemicals. So there was no specific item(s) whose delivery teachers could cite as a consequence of the new curriculum. The three new schools which opened in 1996 had their supplies of equipment sourced from the Ministry. The equipment was a standard package, according to teachers who had taught science previously in the pre-1996 schools. Science teachers in the new schools neither had lists of the apparatus to be supplied: they were not involved in their procurement. My efforts in December 1998 to have the lists from the Ministry's Headquarters were futile despite working with senior people in the Unit concerned with the procurement and supply of apparatus to schools. The list that was obtained was of less help as it was prepared for a tender for supplying the Unit and not for the schools. However, the fact that new schools were supplied with more or less the same apparatus as the old, probably suggested that the same resources were deemed appropriate for the new curriculum. It was, however, not clear whether the supply was an interim measure while reviews of equipment was yet to be made or not.

Moreover, none of the teachers had directly queried the adequacy of the apparatus. As one teacher in a new school had said:

... as a new school we have got almost all the apparatus to use. I commend the government for the job well done. There are just a few items that we are supposed to order.

(Bai, Interview, File 11)

It remained inconclusive as to what the teachers' general silence on adequacy of apparatus signalled, particularly in view of the fact that relatively few science practicals were done during the research. It might be that teachers were satisfied with the levels of resources in the context of teaching strategies they had adopted in the implementation of the curriculum.

The point is that even the most enthusiastic teachers would have found working in the laboratories difficult. This is because of large classes and whole class teaching which engaged all pupils in similar activities at the same time. Possibly, it meant that the exigencies and contingencies of teaching mattered a lot to teachers, compromising the preservation of the philosophy of the curriculum itself. Though teachers are faced with daunting challenges, there appears to be little that schools could do. As noted, school enrolments are controlled by the government. Also, within schools, the administrative and organisational structures are indifferent to the problems that teachers face. This is the subject for the discussion in the next section.

8.2.0 Organisational Structures and Leadership within Schools

As stated in the introduction to this chapter, the implementation of the curriculum is regulated by the organisational and administrative structures in schools. The two areas now explored are: organisational structures within schools and collegiality within science department.

8.2.1 School hierarchy

The hierarchy in any school is to be ordered from top to bottom as follows: School Head; Deputy Head; Assistant Head; Head of Department; Senior Teachers; Teachers; and finally, Assistant Teachers. Assistant Teachers are new graduates on a three-year probation, after which they have to fulfil requirements for crossing a proficiency bar and be designated a Teacher. Various subject teachers in a school were put into four departments.

First, all Heads of Departments and senior subject teachers, together with school Head and the two assistants, collectively form the school management and administration team. The three other departments are 'subject-based' and clustered, with there being Departments of Humanities, Optional Subjects, and Science. Agricultural Science, Mathematics, and Science collectively form the Department of Science(s), under the guidance of a single departmental Head who could be chosen from any of the three disciplines. In five of the schools in the study, three heads of Department of Science were mathematics teachers; and, one each from agriculture and science. In the remaining three schools, the head-ship positions were vacant and the departments fell under the jurisdiction of the school Head, until a suitable candidate was appointed by the Ministry.

Despite the elaborate hierarchy, there existed role ambiguity of the school management and administration team in the implementation of the curriculum. This could be a consequence of the fact that the change coming in the form of curriculum packages is from the Ministry for schools to implement. The team's role is only procedural and administrative, moreso that the curriculum package is 'given' and not to be modified by schools. Documentary evidence from schools showed that the administrative function of the hierarchy was also observed in correspondence originating from the Ministry and destined for science teachers. The In service Officer for the region had adopted the following format in her official circulars, otherwise called *savingrams*:

SAVINGRAM

From: Senior Education Officer (Science). (Name and Signature)
 X (village name) Education Centre.
To: HoD Science
Att: Science Co-ordinator
u.f.s.: Headmaster/Headmistress
Ref: X/EC/1/3/4/4 (1) Date 11 February 1997

RE: SUGGESTED TEACHING MATERIALS

[Document Ref; X/EC/1/3/4/4 (1), Dated 11 February 1997]

Different reference numbers were used with each savingram. A science co-ordinator is a science subject teacher who is given the informal, non-remunerated and token post established for liaison between teachers and Head of Department. Succinctly, a co-ordinator is more than just an informant but, more appropriately, a Head of Department's right-hand man. In terms of implementation of the curriculum, the post possibly served to show how Heads of Department could be distanced from the individual subject areas under their mandate: their (i.e., Head's) primary role was in administration.

However, there were three instances which showed that the hierarchy was ineffective in passing information to teachers. One instance is that of procurement of books which, as already shown, resulted in some schools acquiring textbooks of their choice while others were told that recommendations had to come from the Ministry. Another case relates to the apparent inaccessibility of the school Curriculum BluePrint to teachers. The BluePrint shows that the school curriculum is being phased in over a five-year period during which time more subjects will be introduced to the school curriculum. While teachers complained about inadequate time for teaching the syllabus, they did not have the knowledge that the time will in future be reduced depending on the number of subjects offered in a particular school. For instance, it will drop from

40- to 35-minute periods by the year 2000. Science, alongside mathematics and English, would each have five periods instead of six as was the case during the 1996-1996 period. This information is in the BluePrint, a copy of which was seen in one office of a Head of Department. Further information unknown to teachers was that mixed ability was recommended as the strategy for teaching in the Revised National Policy on Education. The section on workshops shows that teachers had often wondered why the In-service Officer for the region put more emphasis on mixed ability teaching and not on problems of curriculum implementation. It could not be established whether information from teachers and destined for the Ministry of Education get lost in the hierarchy within schools.

On the other hand, the obscurity and role diffuseness of both the departmental Heads and senior subject teachers in curriculum implementation and, their preoccupation and identification with the school management team meant that there was a paucity of advocates of the curriculum, authoritative guidance, professional leadership and other necessary support structures within schools. This resulted in a power vacuum in the teaching of science. The consequences of this were manifest through apparent low levels of collegiality amongst science teachers in a school and teachers' call for appropriate in-service training from the Ministry. This seems to have impacted negatively on teaching, despite teachers seeming to be appropriately qualified.

As Appendix 4 shows, 11 (i.e., 42%) and 10 (38%) of the 26 teachers had less than five years and 6-10 years teaching experience, respectively, and were having their first experience with handling curriculum change. They joined teaching when the previous curriculum was already established, particularly the 42% with 1-5 years teaching experience. In relative terms, the fact that all teachers who participated in the study were qualified implied that one of the minimum requirements for providing Basic Education had been met. However, and consistent with the main theme of this section, the organisational structures within schools appeared not to be properly organised to educe the capabilities and potential of teachers for their effective and efficient use in the implementation of the curriculum. Lack of collegiality amongst science teachers is an illustration of the problem.

8.2.2 Collegiality in science departments

As evidence from the field suggested, science teachers operated in schools more as individuals than collectively as a team. Part of the evidence has already been given in Chapter 7. For instance, while teachers had various difficulties with the curriculum, there seemed to have been no attempts to solve the problems within the science department. Instead, teachers wanted advice from experts at the Ministry. Further evidence from classroom observations and interviews has not shown a common and identifiable philosophy of teaching which teachers, within and across schools, subscribed to. As shown later, they did not identify with mixed ability teaching, although it was actively promoted by the In-service Officer of the region. Neither did any teacher claim to

be practising it nor some other method of teaching: it was just teaching. Another evidence of lack of collegiality manifested itself in terms of the lack of supervisors within science departments. For instance, one teacher talking about a textbook they use and how they sought to bring in contexts relevant to pupils said that such issues were raised at meetings but there were no follow-ups, feedback or monitoring as teachers operated as individuals. He said:

Science to 14, I think is OK. The only problem with it is that it is written for a different context -it is UK material ... It is the duty of the teacher to try to bridge that gap of different contexts ... If you give the text straight to the pupils, then it will serve little purpose because most of the examples are not available in our set up ... We try in science meetings to talk about this but you never know what others are doing, so this could be my position.

(Rak, Interview, File 7)

More evidence that teachers worked as individuals was reflected in the rate at which teachers in some schools had covered the syllabus. Examples of this have already been given in the preceding chapters. As one teacher stated:

... I think that one depends on the pace of the teacher but everything we discuss well in advance about how to go on teaching certain areas ... but then the pace depends on individual teachers.

(Mas, Interview, File 13)

Nonetheless, while some concerns were 'talked about' or 'discussed' in meetings, it was apparent that there were no structures to develop further and enforce them or to monitor their adoption and implementation. This not only suggests leadership problems but also weak collegiality as individual science teachers did not see others as a *reference point* or *reference group* with whom issues could be raised for discussion on a daily basis or, as and when they arose. Departmental meetings thus became a formal forum for registering grievances only, not for resolving them. The meetings comprising subject teachers for Agriculture, Mathematics and Domestic Science, did not culminate in or promote collegiality amongst science subject teachers and were possibly ineffective in addressing specific concerns of teachers. No other teachers shared their 'real' day-to-day experiences in using the curriculum. Collegiality also suffered due to a number of factors. The low number of science teachers per school all with similar qualifications meant that any one teacher was poorly placed to offer academic and professional leadership to others. Also, with no one specifically designated as the curriculum advocate, and with the substantive Head of Department concerned more with school administration than with ensuring quality of teaching, there was no driving force to unite teachers in the implementation of the curriculum.

The individualism of teachers was also manifest through their requests to me for professional guidance. While at least eight teachers requested that I mount 'demonstration' lessons and workshops, none of the requests originated from a Head of Department. One science teacher, a

Deputy Head, asked for copies of my report out of her interest in 'knowing the status of science teaching in the region'. For others, the requests originated from concern over whether they (teachers) were "doing the right or wrong things", which perhaps showed an inclination to fidelity of implementation. I found teachers' strength to be in their willingness to learn more about the curriculum. As other teachers had indicated their need for workshops from *experts*, one could opine that teachers tended to identify more with the Ministry than with the profession or, rather, science departments. This further weakened the collegiality amongst science teachers. The weak collegiality was also a consequence of the fact that the curriculum was developed outside schools.

From a methodological perspective, the requests for workshops demonstrated that teachers wanted reciprocative (i.e., two way) relationships with me, which created a dilemma in Phase 1 of the study as more classroom observations were planned for Phase 2. Teachers were appreciative, however, of the latter constraint. Workshops and teaching demonstrations could not be made on the grounds that teachers had widely complained about their neglect by the Ministry. Nevertheless, throughout the study I realised from teachers' comments that they had little faith in the guidance rendered by the In-service Officer for the region. Any tension or difficulties that existed between the two camps had the potential to be inflamed by any undertaking in the form of large-scale workshops which might have overlooked the context of operation (e.g., constraints, policy decisions) of the in-service structures at the Ministry. Evidently, the Ministry had become a dominant concern overshadowing possibilities for co-operation among teachers. The next section explores the actions of the Ministry with regard to how they impacted on curriculum implementation.

8.3.0 The Ministry of Education and Curriculum Implementation

The section focuses on two interrelated areas which indicate the position of the Ministry in the implementation of the curriculum. They are: In-service workshops and national examinations. They are discussed separately. A short overview of the general responsibilities of the Ministry is in order.

The Ministry of Education controls all the 230 CJSS in the country. Some of the roles the Ministry played in the centralised education system have already been covered. These include:

- the development, dissemination and introduction of curriculum packages to schools;
- administering and regulating the transfer of pupils from primary schools to CJSS;
- procurement and supply of material resources for the curriculum and,
- recruitment and professional development of teachers.

The above generally suggests the deterministic role the Ministry had in the curriculum. With the centralised administration, it appeared difficult to ensure that the four strands above articulated well with each other in practice. Concerns with pupils, textbooks and shortage of teachers exemplify the difficulty. In-service workshops and national examinations are discussed below as key illustrations of how the Ministry appeared to fail teachers.

8.3.1 In-service workshops

Generally, teachers felt that the Ministry of Education has displayed 'diminished' responsibility toward them. There had been no workshops first, for the introduction of the new curriculum into schools; and, second, for addressing the teachers' immediate and pertinent concerns. Teachers' immediate concerns were raised variously in this work and encompassed three broad issues relating to scope, depth and breadth of the syllabus; priorities within the syllabus and the abilities of learners. These concerns lead to two key areas about the workshops. They are: i) their organisation and conduct and ii) major problems with workshops and their impact on the implementation of the curriculum. They are discussed below.

8.3.1.1 Organisation and conduct of workshops.

While about seven workshops (which number has been confirmed by the In-service officer for the region) had been held since the inception of the curriculum in January 1996 and by September 1998, they were mostly on mixed ability teaching. However, the evidence from documents collected from schools shows that some teachers' concerns were attended to through workshops. For instance, the document, Ref.: X/EC/1/3/4/4 (1) dated 11 February 1997 on "Suggested Teaching Materials", from the In-service Officer to teachers read:

Please find enclosed suggested teaching/learning activities following the X (village name) Cluster meeting late last year. Please adapt these for use in your classes. Any suggestions for future improvements are welcome.

Another Savingram dated 11th October and announcing a workshop scheduled for 18th October 1996, showed that three areas of teaching were on the agenda. They are:

- i) Suggestions on how much to cover in each science module (for Form 1 and Form 2);
- ii) Sample questions on the modules you are working on ...
- iii) Scheming and record of work and,
- iv) Future workshop topics.

(Source; Unreferenced Savingram dated 11 October 1996)

The invitation also showed that the workshop was a follow-up of the one held on the 4th October of the same year and that individuals had been assigned tasks previously. It read:

Participants are reminded to come to the meeting with their assigned tasks completed ... You are also reminded that you are to bring enough copies of your work for other participants to look at.

(Ibid.)

Clearly, the workshops seemed to be teacher-centred by seeking both to actively involve teachers in identifying and in addressing problems of implementation of the curriculum. However, this seemed to be an inappropriate approach. As observed earlier, the low levels of collegiality between science subject teachers in schools were a consequence of the fact that teachers held similar qualifications and lacked subject- or department-based reference groups. This appeared to be reflected in a general resentment of and disinterest in the workshops which stemmed mainly from teachers' expectations of expert advice and wisdom from resource persons other than fellow teachers. An excerpt from one teacher's interview summarises the problem(s). He said:

... Experienced people should be able to come and tell everybody how to deal best with each topic because this thing (syllabus) is the first go. We do not know what examinations will be like; we do not know to what depth the syllabus is to be treated: we do not know a whole lot of things. There should be some sort of co-ordination that this topic should be treated this way ... you will get this type of material from here to there. If you were going to treat Water, this step should follow this step, then there is uniformity ... (Regarding one workshop, he said) I must be frank, it did not turn out to be what I anticipated ... But I found out that people were delegated to attend to certain aspects of the syllabus and when we meet, either the person concerned had delegated somebody else who does not know what it is all about or they say I did not prepare ... But personally, I felt I was wasting my time ...

(Dus, Interview, File 6)

The above view clarifies the lack of proper resource persons at the workshops organised around school clusters. Schools were clustered for the sake of administrative convenience as the In-service Officer catered for at least 15 schools within one region. As alleged in the above citation the fact that some resource persons reneged compromised the value of the workshops as their organisation and effectiveness defied teachers' expectations. On the other hand, attendance at the workshops faced two further problems viz.; their timing and accountability of attendants to their colleagues in their respective schools. These problems are inter-related and will be so treated.

Workshops ran during school term and schools were expected to release teachers to attend. In a Savingram of 29th January 1997, announcing to schools a mixed ability teaching workshop, it was stated:

There will be a Science Mixed Ability Teaching workshop for the above-mentioned schools starting on the 19th to 21st February 1997. ... Each school is expected to send as many teachers as possible, preferably all teachers of science in the department ...

(Source: Savingram Ref.; X/EC 1/9 (60))

According to teachers, school Heads and teachers did not comply with the request as that would have meant losing more teaching time teaching and providing more teachers to stand in for those away. This typically resulted in low attendance at the workshops which appears to be acknowledged by another correspondence (Ref.: X/EC 1.3.4.4 (9)) of the 30th October which required that only one teacher per school to attend the two-day workshop on communications, held on 13th and 14th November 1997. Incidentally, the latter is one of the areas which one teacher had indicated that it was not covered in any of the textbooks they had. The In-service Officer also queried the inclusion of the section (electronic communication) in the syllabus, as she said it found its way into the syllabus through *executive decisions* (discussed below) of some members of the Task Force.

Another weakness of the workshops was their low frequency, duration (typically one to two days), and intensity, which seemed incommensurate with the level of assistance teachers felt to be necessary. On the other hand, teachers also attended workshops on a rotational basis. This meant discontinuity in professional development for any one teacher. Individual teachers, it seems, attended for their own benefit and were least accountable to their colleagues. Some teachers reportedly attempted to give feedback to others and it had often turned out to be "disappointing". This could be understandable if due consideration is given to the wide range of problems and needs teachers had which no single workshop could address. On the other hand, teachers cited lack of documents from workshops to circulate to all others as a hindrance in developing and enhancing their ability to implement the curriculum. All this, in effect, meant that dissemination of information through workshops and individual science teachers was ineffective as a strategy for promoting informed implementation of the curriculum. Teachers generally did not benefit from the arrangement. On the other hand, failure by workshop organisers to circulate proceedings of workshops to schools increased further the inaccessibility to teachers of information on the science curriculum.

8.3.1.2 Major problems with workshops

Problems of resource persons and poor dissemination of information from workshops has been discussed above. The workshops further highlighted the problems with having one In-service Officer working seemingly independently of other stakeholders in the Ministry. She was interviewed at the time when school visits and interviews with teachers had been completed. This was for purposes of corroborating or otherwise what teachers had said about their involvement in the curriculum. However, her role in implementation of curriculum is seen in the context of professional advice rendered through workshops. It is in this context that four major problems that faced the workshops are examined.

The first problem is that teachers questioned whether mixed ability teaching was advocated for teaching the syllabus or, if it were the personal preference of the In-service Officer as seven of

about ten workshops had been on mixed ability teaching. A definitive position on this could be found in the Revised National Policy on Education which followed from the recommendations of the National Commission on Education of 1993. The policy document espouses the promotion of mixed ability teaching across schools as the main teaching strategy within the 10-year Basic Education Cycle. So it would appear that the In-service Officer was following the policy of which teachers were oblivious. In part, this is a possible consequence of the inaccessibility of policy documents to teachers, of the low general awareness and education about the curriculum, and of the role ambiguity of key personnel in schools in the curriculum implementation process.

The second problem concerned the role of the In-service Officer in the implementation of the curriculum which was viewed with ambivalence by teachers. The Officer had allegedly disassociated herself from some matters and debates pertaining to the nature of the syllabus, claiming that they fell under the jurisdiction of the Curriculum Development Unit at the Ministry. The curriculum was developed under the auspices of the said unit and the Inservice Officer seemed to identify herself as one of the 'users' of the curriculum. In my meeting with the officer, she raised two important issues related to that. Although she had been a member of the Task Force that developed the curriculum, she had not been happy with it (i.e., curriculum) due to some members of the Task Force taking '*executive decisions*' on behalf of the majority.

This should be viewed against the observation that at least 13 of the 20 team members (see Ministry of Education, 1995a, and Appendix 3) were not curriculum developers themselves although they had some experience in teaching. The officer's resentment of the curriculum seemed to be presiding over what she called '*someone else's baby*', adding that things were never right from the beginning. On the other hand, the resentment of and disassociation from the curriculum might indicate that teachers raised questions which the officer could not answer. Teachers' complaints about the workshops seem to justify this. The second point that the officer raised was that there was a vague definition of her tasks and those of the CDU in in-servicing teachers and overseeing the implementation of the curriculum. This caveat in organisational structures of the Ministry meant that there was weak or relatively non-existent co-ordination of efforts to guide implementation.

The third problem is that the workshops created more confusion about the curriculum than would probably have been the case without them. First, as was confirmed by the In-service Officer, she did not distinguish between the new curriculum and the previous three-year one, which ran in the mid-1970's to December 1986. As a consequence, teachers had been referred to the materials (books, teachers guides, worksheets) of the curriculum, or when such were not available, and in the words of the officer, teachers were:

... asked to think back to the time when they were students themselves and use that as a guide for teaching ...

(Inservice Officer, Interview account, May 1997)

This was corroborated by some teachers (e.g., Gar and Jan) who had complained that they did not have such materials and had difficulty in getting them from other schools. The problem this created was that the materials were modified versions of the Scottish Integrated Science which were used before Botswana's first National Commission on Education of 1976 recommended widespread changes to education. The use of the materials was therefore an antithesis of the current reforms and curriculum. On the other hand, it was not clear if the use of the materials was sanctioned by the Ministry. Perhaps the use of curriculum materials explained some of the influential factors in the development of the new curriculum in which the Officer had participated. The forgoing meant that teachers received somewhat contradictory views about the curriculum. One view portrayed it as a novel development, while the other drew little or no distinction between it and the antiquated one.

Workshops thus appeared to work against the implementation process. For instance, some teachers' perceptions of their pupils' language problems were generated in one workshop; teachers' immediate concerns were not addressed to their satisfaction; and, there was also the ill-defined role of the In-service Officer. These factors impacted negatively on the implementation of the curriculum. For instance, the possibility of breeding and promoting complacency amongst teachers was strong since those in "authority" had failed to deliver answers to problems and issues raised by teachers. A case in point, amongst others, was the pervasive concern with "grade D" pupils, enrolled into CJSS despite low achievement at PSLE. Teachers perceived that to be a policy and political issue beyond them and one which could be resolved by the Ministry although the "grade D" pupils were a constant *problem* in teaching. Workshops also failed to explain how such pupils could be dealt with in mainstream education and teachers were unanimous that the pupils stood to benefit nothing from it.

Possibly, the key consequence of the workshops' failures has been to provide and develop points around which teachers' views on curriculum implementation were unified, anchored, and/or, revolved. This led to the direct and indirect creation of a universal culture or 'group think' amongst teachers. For instance, all teachers in the study were predisposed to talk of their problems as a way of justifying their practices. This is evident in previous chapters. This tendency, which was reinforced by *inappropriate* workshops, tended to kill any potential enthusiasm for creativity and for in-house and collective problem-solving and progressive thinking amongst teachers. The problem is that the workshops came at an early stage in implementation when teachers' quest for understanding the curriculum and their willingness to learn as a way to searching for a focus in practice, were high. Consequently, the problems might

have become hardened or fossilised too early in the life of the curriculum. This is a regrettable occurrence because the problems force teachers to adopt teaching strategies which would not preserve the meaning of the curriculum.

The fourth problem with workshops was that there were questions raised concerning the appearance of only one In-service Officer. This led to issues relating to the ownership of the curriculum, which became inevitable to teachers by virtue of the Ministry's low level of involvement in its implementation. Some teachers thought there were other officials who were not doing their job. One teacher said,

Teacher .. school inspectors never come to observe us - the last time they visited the school was in 1994 but did not go into classes. They dealt with the administration personnel.

Researcher: Has that impacted on your teaching?

Teacher: Yes, because the education officers are close to the Ministry of Education - if they could visit the schools, they could be in a better position to know our plight and communicate to relevant authorities. The education officers are always in Gaborone and do not know our problems here.

Researcher: Are you saying you are acting in isolation with little assistance from the government?

Teacher: Exactly!

(Rak, Interview, File 7)

The citation is important in that it highlights that teachers do not seem to know other officers, if any, at the Ministry of Education who are 'partners' in the implementation of the curriculum. Teachers probably experienced some sense of loss and desperation as schools were not able to provide the guidance and professional development they needed. Furthermore, the citation appears to show not only concerns about the identity of the curriculum itself but also that of the teachers. On the other hand, it has already been indicated that teachers' sense of self-esteem, confidence and collegiality in departments were rather low.

This point relates to how hierarchies or structures within and beyond schools overwhelmed and perhaps frustrated those teachers who handled the curriculum in schools. Paradoxically, while teachers found themselves trapped in a seemingly ineffective set-up in schools, their hope for external intervention was crippled by communication barriers and uncertainty about the 'significant others' in the implementation process. On the other hand, the hierarchy seemed to reinforce the view that the curriculum was both external to and imposed on schools. Nonetheless, it did not seem this alienated teachers to the curriculum. For instance, it has already been shown that no teacher rejected the curriculum but, instead, showed their willingness to learn about it through proper expert guidance. Since this was not forthcoming from the Ministry, the teachers'

calls for sample examination papers was in pursuit of their quest for an authoritative "voice" or document on the curriculum. The nature of the examinations is discussed below.

8.4.0 National Examinations

At the time of the study no examinations for the curriculum had been sat. In effect, this means that no proper examinations influenced the conduct of teaching. What is important is that the impact of the examinations on curriculum implementation cannot be discussed in any great detail. On the other hand, the sample examination papers made available to schools were fraught with problems which are discussed later. The discussion of examinations here illustrates two things. They are: a) they highlight priorities of the syllabus as seen by examiners and, b) they showed lack of collective responsibility and action in the implementation of the curriculum by the Ministry.

The Examinations Research and Testing Division developed and disseminated to schools documents comprising two sample examination papers and guidelines on structure of examinations, namely, the Junior Certificate Examination Assessment procedures. The documents indicated the form and shape the examinations were to take as well as broad areas (i.e., science content, applications, skills) of the syllabus which were to be assessed. They form the basis of discussions.

According to the document on assessment procedures, three areas (referred to as *dimensions* in the document) were to be assessed in examinations. The three are:

- "Dimension 1: Knowledge and understanding of scientific concepts and relationships. [*This covered three areas*]: Knowledge and recall of scientific concepts; understanding science concepts and relationships; use of scientific vocabulary, terms, symbols, quantities and units;
- Dimension 2: Application of scientific concepts and skills. [*This covered*]: application of scientific knowledge and understanding to new situations; using information to identify patterns, report trends and draw conclusions; translation of information from one form to another; processing of information from graphs, tables and charts; representing information in the form of graphs, tables, and charts;
- Dimension 3: Experimental and investigative skills [*viz.,*] designing and planning an experimental procedure; making predictions, proposing hypothesis and suggesting solutions to problems; carry out scientific investigations; interpreting and drawing conclusions from observations and experimental data; recording observations, making measurements and estimates and processing data; suggesting improvements for further investigations."

(Ministry of Education, 1997b, p. 1)

Continuous assessment (CA) is to be incorporated into the assessment with time (*ibid.*, p. 3). The percentage weighting of examination papers and their constituent dimensions for 1996-1998 period (before implementation of CA) were given as follows:

Component	Knowledge and understanding	Application	Experimental Skills	Totals
Paper 1	35	5	-	40
Paper 2	15	15	30	60
Total	50	20	30	100

Table 8.1: Percentage Distribution of Areas for Assessment in Examinations

(*ibid.*, p. 3)

Paper 1, which is exclusively multiple choice, is of 90 minutes duration. Paper 2, comprising of short answer questions and structured questions, is given 135 minutes (*ibid.*, p. 2). As the Table 8.1 shows, knowledge and understanding is given a higher weighting than applications and experimental skills. The document was finalised in 19th August 1997 (*ibid.*, p. 4) and reached one school, as per the date stamp, on the 17th December 1997. This was approximately two years after the curriculum was introduced into schools.

It is not clear how the weightings in Table 8.1 related to priorities, if any, in the science curriculum. On the other hand, classroom observations made before and after the arrival of documents in schools have shown that teachers placed relatively low emphasis on applications of science to everyday examples. It is intriguing that the same is true of assessment procedures. Generally, this could possibly indicate an area of difficulty or perceptions of the curriculum common to both teachers and examiners.

Evidence of the impact the Junior Certificate Examination Procedures had on teaching is also not available. Firstly, all but one teacher did not discuss it during interviews. Secondly, the availability in schools of the document was probably eclipsed by the earlier release of the two sample examination papers which, as per a date stamp for one school, were received on the 8th October 1997. However, it is inconclusive if the assessment guidelines had reached teachers as they had arrived during school vacation and the copy collected in the field was supplied by a Head of Department (sciences) in one school.

The sample examination papers contained relatively insignificant questions on applications of science to daily life situations. This probably showed that the area carried a low value in examinations. However, the papers generated confusion and anxiety amongst teachers as they introduced new demands on interpretation and understanding of the curriculum by teachers. Teachers found inappropriate the content level of some questions, probably pitched to Cambridge

'O' level standard. This not only illustrated new demands and expectations to be met, but also the inadequacies of specific objectives and textbooks as Teachers' Guides. Question B1 on digestion illustrates the problem well. It is also chosen because I had observed the lesson on the topic.

The structured question, the first in Section B of Paper 2, was based on an experiment in which one of the two test-tubes containing a mixture of 20 cm³ of starch solution and 1 cm³ of amylase solution, was put into a water bath at 20 °C. The other test-tube is placed in a water bath at 30 °C. Tests for starch were done on samples of the mixtures, drawn from the test-tubes, at 1 minute intervals. The questions pupils were asked required in-depth understanding of theory. Some of the questions were:

- a) Describe how you would carry a test for reducing sugar, stating what observation would indicate a positive result;
- b) Referring to table 1 ... (iii) state why both starch and reducing sugar were present in some of the sample;
- c)
 - (i) Suggest one precaution that should be taken if the dropper or pipette had been used to remove each sample;
 - (ii) Describe a suitable control that could have been included in the investigation;
 - (iii) Where in the alimentary canal would a similar reaction occur?

(Ministry of Education, 1997a, p. 7)

Classroom observations of lessons on digestion did not show that pupils were prepared to meet the competencies required in the question. This seemed to be corroborated by the objectives in the syllabus of the unit on Digestion. The General objective read:

7.2.4: acquire knowledge of how food nutrients are made available to the body tissues;

And the Specific objectives were:

7.2.4.1 define digestion.

7.2.4.2 describe parts of the digestive systems and their functions.

7.2.4.3 state that enzymes are responsible for the digestion of food.

7.2.4.4 state the end-products of starch, protein and fat digestion.

7.2.4.5 carry out an experiment to show how food is absorbed into the blood stream.

7.2.4.6 distinguish between defecation and excretion.

(Ministry of Education, 1995a, p. 8)

The lessons observed were theory-based and no experiments were performed to show absorption of food into the blood stream. Also, the treatment of the food absorption process was insufficient to meet the requirements of the examination question. The theoretical knowledge that pupils had was inadequate to permit them to attend to the question fully. Evidently, there was a big gap in or mismatch between the requirements of the examination question and those of the objectives. This

became apparent at a time when 20 of the 36 months of the first phase of the curriculum were utilised. The impact of the sample examination papers on teaching was diverse. Some teachers taught to meet what they perceived to be the demands of examinations. One teacher said:

... we use those for guidance and we do not want to deviate from the set standard.

(Mar, Interview, File 4)

One other teacher said she used standard Cambridge 'O' Biology textbooks (e.g., Mackean and Roberts) to try to

... bring in as much material as possible and to match the standard set by the examination papers.

(Jan, Discussion, File 14)

Other teachers also used the textbooks as reported earlier. The In-service officer of the region said she was concerned with the development which should be seen against the background that seven or so workshops for teachers had preceded both the release of the examination papers and the guidelines for assessment.

The development further highlighted gaps in the structural organisation and operation of the Ministry. The evidence clearly showed that the In-service Officer and the Examinations Division acted independently of each other in informing curriculum implementation. Also, the papers were not routed to schools via the Officer, suggesting a possible violation of protocol or use of power by the Examinations Division. In terms of teaching, teachers had to respond to the different demands emanating from different units which left teachers even more uncertain about their relations with various organs of the Ministry. But, as it has been said earlier, the problems teachers encountered were unattended to by the Ministry at an opportune moment in the implementation of the curriculum.

However, and finally, the 1998 Junior Certificate Examinations marking the end of the first phase (1996-1998) of the new school curriculum, and the first of the science curriculum (including various subject disciplines) were held between October and November 1998, at least four months after the fieldwork. The examinations selectively and decisively put emphasis on science content. Paper 1 was purely knowledge-based: there were no questions drawn from the pupils' environment. In Paper 2, only one optional question worth 15 out of the possible 90 marks was on ecosystem. All other questions were based on standard textbook applications of science. The examinations marked the end of many months of confusion and uncertainties about the curriculum. They also marked the beginning of a new era in which their influence in teaching started in January 1999, the beginning of a second phase of the five-year phased-in

implementation of the school curriculum, of which science is part. Quite clearly, the position of the out of school experiences in the curriculum remained undefined.

8.5.0 Summary

Attempting to make sense of the data presented in earlier chapters might not have worked without the data in this chapter which has captured some of the intricacies and salient aspects of the organisational environment in which the curriculum was implemented. Inadequate or weak leadership prevailed both within and outside of schools.

The role of the school administration and management teams, senior subject teacher (science) and Head of Department (science) in particular, in guiding and monitoring curriculum implementation were ill-defined. Furthermore, the Ministry of Education inadequately responded to problems which were identified by teachers in the use of the curriculum. There was also uncoordinated guidance as well as piecemeal delayed provision of vital documents, as was the case with the sample examination papers. The approach created confusion among teachers as different interpretations and requirements of the curriculum, which appeared not to be easy for teachers to reconcile, became apparent. The in-service workshops further accentuated a general lack of a common strategic focus by units in the Ministry leading, in part, to loss of philosophy or paradigm on which the curriculum was founded.

However, teachers appeared to be open-minded about the curriculum and gave themselves over to a guided search for a new direction in teaching. For instance, their calls for appropriate workshops was partly borne of their need for efficient and effective use of resources and thus seeking to avoid indulgent teaching lacking in both purpose and direction. Nonetheless, the apparent failure of the Ministry to respond in a timely fashion seemed to negate teachers' perspectives on their reality (e.g., occupational identity) while, simultaneously, an impression of the curriculum to be a self-perpetuating liability was being created. Teachers were clearly alienated from each other, the Ministry, the curriculum and the pupils. However, none of the teachers rejected or disassociated themselves from the curriculum in the face of difficulties and challenges they faced in its implementation.

Generally, the science curriculum was implemented within structures and establishments that did not support it. It also seemed that its meaning was elusive to teachers as there seemed to be a widespread misunderstanding of the curriculum's requirements, in particular, those relating to priorities within it and the linking it to the pupils environment. The use of the science curriculum within the Basic Education framework as a vehicle to promoting wider scientific literacy was generally lost and probably restricted by the challenges of implementing the curriculum. Paradoxically, the implementation capability of schools remains unknown.

Overall, the study has shown some of the challenges of provision of Basic Education: a politically-inspired product to which the government displayed a strong political will and financial commitment. This has been demonstrated over the last two decades through a rapid development of physical infrastructure, provision of various material resources and teachers through purpose-built institutions. Appropriately, the new school curriculum was implemented in a young, dynamic and rapidly expanding education system which was not only symbolised by the increase in the quantity of schools and pupils, but also by the introduction and predominance of new and young teachers into schools over the last decade. The rapid growth has also outgrown and antiquated structures for curriculum development and implementation existing within the Ministry of Education. In general terms, the study shows both the general and specific attributes of implementing a locally developed curriculum in a rapidly expanding education system in a developing country. In the subsequent chapters, the findings are put in a wider context of literature on implementation of curriculum change.

CHAPTER 9

PRELUDE TO THE INTERPRETATION OF FINDINGS

This prelude gives a background to the interpretation of the research findings. It seeks to explain the position adopted in the process and to outline the organisation of the presentation.

Two chapters address the second subsidiary research question namely, What explanations can be given of the research findings? Discussion of findings in Chapters 5 to 8 were a preliminary and descriptive interpretation of the data. The two chapters develop the interpretation a step further by locating the findings within a wider literary context on change theory and implementation of curricula reforms in general. The interpretation is guided by three key considerations. The first is borrowed from Goetz and LeCompte (1984). They state that interpretation of data requires that researchers "specify what the data mean for the question asked in the study and why particular meanings are salient. Interpretation includes explanatory statements of cause-an-effect relationships, whether predictive or retrodictive" (p. 206). The second consideration is that of creating strong links between data collection, analysis and interpretation.

This study was conducted mainly within a process perspective which focused on what teachers did in practice. The process perspective is also used here as part of the main framework for interpreting the findings (cf. Goetz and LeCompte, 1984). This ensures consistency and continuity in the conduct of the study as data interpretation is not divorced from the overall framework which guided data collection (cf. Brown and McIntyre, 1993, p. 23) and its analysis (Lofland and Lofland, 1984). Thus the research findings are seen as comprising some form of an 'interpretative structure' (Stenhouse, 1982, p. 276) borne of the teaching processes. As Stenhouse explains, "pedagogy has not only to communicate an interpretive structure, but to construct it as it goes along ... and is an important insight to bring to accounts of classroom" (p. 276). The interpretative structure is complete in 'structural corroboration and referential adequacy' which Fetterman (1988) defines thus:

Structural corroboration refers to the extent to which pieces of puzzle fit together and validate each other ... Referential adequacy involves comparing critical disclosure with the phenomenon. It represents a form of inter-judge or intersubjective agreement ... The product of this venture is the re-education of perception for the teacher, the student, the administrator and the scholar (p. 12).

The citation clarifies the targeted audience of interpretation. This forms and defines the third framework guiding the interpretation of data. The audience is seen broadly in terms of research-practice relationships (i.e., how research informs practice), in which case a 'critical model' of research is followed:

Here research may relate to a particular policy problem, but this is likely to be a perennial issue rather than a problem facing a particular group of practitioners at a particular point in time ... The aim .. is to contribute to discussion in the public sphere, and thereby aim to 'enlighten' various sorts of practitioners (Hammersley, 1994, p. 141).

Working in education within the above "enlightenment paradigm" (ibid.) closely equates to 'pedagogic research' (Webb, 1990; Crossley and Vulliamy, 1997) which:

... is research into the processes of teaching and learning and/or factors which directly affect these processes. It employs methods of enquiry, ways of presenting findings and publication outlets that are eclectic, pragmatic and readily accessible to teachers (Webb, 1990, p. 3).

The overall attempt is to engage in some form of intellectual synthesis in which teachers' actions in and accounts of implementation of curriculum become understandable through drawing on and making connections with literature on policy implementation.

The interpretation is eclectic and the debates will be put into the perspective of existing theories or positions in the literature by way of summary. The eclectic interpretation serves to avoid deterministic positions which might preclude a fuller appreciation of and significance to curriculum implementation of the research findings. The theories in the literature themselves are brought into the study to illustrate how data supports, or is supported by them, and to illustrate how the data contributes to the theories and to understanding of curriculum implementation. The interpretive approach provides some perspective of the work but without constraining the understanding through what in some cases might be in insufficient and deterministic frameworks.

The interpretive structure arose from the data analysis and closely matches the presentation of the research findings in Chapters 5 to 8. Subsequently the interpretation of findings is organised into four sections:

- a) *aspects of the teaching environment*. With the classroom as a unit of analysis, the aspects of the teaching environment comprise teaching strategies and the associated influential factors such as textbooks and examinations;
- b) *accessibility of the meaning of the curriculum*. The section tries to use both empirical observational evidence and teachers' accounts to critically explore clarity and accessibility of meaning to teachers of the implemented curriculum. In teaching, the use of examples from out of school experience, as well as the position pupils occupied in teaching, are used to explore the issue;

- c) *management of change in the wider organisational environment*. Here the intention is to locate the implementation of the curriculum within structures, internal and external to schools, which constitute its operative context;
- d) *the teachers' role in change implementation*. The three sections above create a background which helps in critical examination of the teachers' role in the implementation of the curriculum. Considering teachers' role last is also strategic for it avoids substituting the teacher for the curriculum as the focus for the study.

Sections a) and b) are on aspects of classroom teaching and learning. They are discussed in Chapter 10. Sections c) and d) relate to management of change, and form the subject of discussion in Chapter 11. Overall, the interpretation of data strives for positions which are *true* to the views and actions of the participants in the study. In substantiating my views, full reference shall be made to the data collected in the study. First, this promotes interpenetration of data and analysis, hence minimising what Lofland and Lofland (1984, p. 146) call "segregation error". Second, the approach is aimed at minimising personal bias and problems of validating interpretations (see Shaw, 1978). Also, because the interpretations represent a particular view of 'reality' in the data as seen by the researcher (see Bogdan and Biklen, 1998; Anderson and Arsenault, 1998; Sarantakos, 1994; Power, 1977), full reference to data gives readers a basis for judging the validity and reliability of the views presented. Chapter 10 and 11 were developed based on the positions discussed above.

CHAPTER 10

CLASSROOM CURRICULUM

This chapter focuses on interpreting findings of classrooms transactions. The interpretation is presented in two separate sections: aspects of teaching environment; and accessibility of the meaning of the curriculum

10.1.0 Aspects of the Teaching Environment

Chapter 5 showed several predominant features of the teaching environment. Amongst them was the widespread and varied use of textbooks and, rather less conspicuously, was concern with examinations. In Chapter 6, the development of concepts during teaching had generally been noted to be shallow. Teachers linked the observation to the difficulties in operationalising instructional objectives or, rather, the attainment targets. This section focuses on the use of textbooks, instructional objectives and examinations, as they were the key areas of concern for teachers. The section ends with locating the arguments within the technical rationality thesis. This helps to reflect on the arguments made.

10.1.1 Use of textbooks

The textbooks which the Ministry of Education recommended for use with the curriculum were for the previous curriculum. These were widely available across schools in the study. Most teachers felt that the textbooks "*Science by Investigation in Botswana - Books 1 and 2*", did not adequately cover all topics in the syllabus. It is important to note that teachers used the textbooks regularly and made them part of their predominant pedagogic strategies. It is argued here that despite the caveats the use of the textbooks created a narrow scope of curricula content and, given the circumstances, symbolised what teachers found to be an acceptable teaching strategy. In other words, textbooks were not only an immediate and specific source of curricula content, but, they were also taken as the source of acceptable pedagogic, appropriate conceptual structure and curricular organisation. The evidence given in Chapter 6 showed that teachers not only followed textbooks, but they also did not elaborate on to what the texts contained. For example, the lessons on Ecosystem, Carbon Cycle, and Force (Chapter 6) confirmed the point that teachers did not go beyond the curriculum in the textbooks.

The practice created a difficulty in reconciling the use of textbooks with teachers' accounts of the inadequacies of the texts. First, despite the fact that the textbooks were for the previous curriculum, textbooks are naturally fraught with controversies. For instance, economies of textbook publication preclude inclusion of peculiarities and the socio-political constraints of environments in which the textbooks are to be used (see Brathwaite, 1985; Layton, 1985; Tamir, 1980) and are "frequently superficial or designed to make science easier to teach rather than to

meet sound educational goals" (Layton, 1985, p. 168). Teachers may in the first instance not be aware of these controversies, hence their expectations on the textbooks to "provide the desired width, depth, and accuracy in the coverage of curricula topics" (Dreyfus, Jungwith and Tamir, 1985, p. 92). Thus, in terms of classroom instruction, textbooks drove the teaching rather than supported it. The teaching, and indirectly, the curriculum became textbook-centred, controlled and inflexible (cf. Yager, 1995, p. 24). Teachers were also not seen to construct or infuse the meaning from the science textbooks into their own interpretation of the curriculum. It remains questionable, however, whether the observed use of the textbooks was viewed by teachers as a proper and easier way of teaching the syllabus to mixed ability classes whose science background from primary schools was reportedly discouraging (see also Kahn, 1990b). The observation is made particularly in light of the combined and extensive use of textbooks in reading assignments and in light of the question and answer recall teaching sessions noted during fieldwork.

The second position on the use of textbooks relates to the fact that in recommending the use of textbooks the Ministry was, in effect, implicitly defining "the curriculum". As Altbach (1987) states, textbooks 'circumscribe the curriculum' (see also Tobin, Tippins, and Gallard, 1994), though not in every case. From an historical viewpoint, teachers in Botswana are accustomed to curriculum change as a complete curriculum package which, as Fensham and Gunstone (1995) notes, would "control teacher behaviour, rather than teachers controlling the package" (p. 235) which resulted in a "teacher proof curriculum" (ibid.). Thus, textbooks established a new framework of operation for teachers such that teachers were possibly at loss concerning their role both in class and in curriculum implementation. More succinctly, and as Diana Mulcahy (see Galant *et al.*, 1995, p. 252) state, "there is a dialectical relationship involving the position of teacher and textbook" in the classroom such that "the teacher both positions and is positioned by the textbook". But what is missing is how both the teacher and the textbook were positioned by the science curriculum itself. In terms of the implementation of the curriculum, it can be argued that little adoption and adaptation of curriculum occurred in practice particularly if it is accepted that the information in textbooks is relatively incomplete.

Further, it is unclear whether or not the Ministry saw the new curriculum as the same as or as different from its predecessor. On the basis of the complaints from teachers it appears that the Ministry had not reconciled the demands of the curriculum with those met by the textbooks. Overall, the two positions on textbook use show two necessarily conflicting pressures on teachers. These are the demands of understanding and providing direction to the new curriculum and teaching on the one hand, set against directives or messages on the demands of the curriculum seen from the Ministry's position on the other. Consequently, textbooks appeared to have caused a tension which compromised teacher decision-making in the implementation of the curriculum. This explains why teachers found the textbooks lacking in some respects, yet they remained a potent force in the implementation process. In such a situation, the guidance the syllabus

document gave teachers is unclear. This leads to consideration of the instructional objectives defining the syllabus which, like the textbooks, were seen to be restricted in both breath and scope.

10.1.2 Instructional objectives

As teachers' accounts and empirical evidence showed in Chapter 6, 'teaching to objectives', sometimes characterised by shallow and dense content coverage in a limited space of time was predominant across classes studied. On one hand, it showed teachers' concern with time, content coverage and finishing the set of modules set for a given term (semester). This also showed the influence of the institutional contexts in the implementation of the curriculum. On the other hand, the 'teaching to objectives' approach demonstrated the ambiguity of the objectives in setting and delineating priorities in the syllabus and in teaching. Instead, they restricted teaching, as instanced by teachers complaining about the scope, breadth and depth of coverage required by any particular objective. Two aspects of the problem are discussed. One regards the position of objectives in teaching in general, while the other focuses on creating the link between observed classroom practices and objectives in the syllabus. The first focus considers the general position of objectives in teaching.

As the evidence showed, teachers were aware of the problem particularly that of expanding on a specific objective to broader and general areas of the subject. From the teachers' viewpoint, the objectives emerged to be prescriptive and conservative in terms of guidance. As in the case of the National Curriculum in Britain, the interpretation of the learning objective superseded the intention of the policy-makers, as the objectives were regarded both as indicators of the desired pupils' performance (Oakley, 1993), attainment targets and of what should be taught. Stenhouse (1985a) articulates the problems well. He states that "reflecting on objectives does not greatly help the teachers to achieve them even if they [i.e., objectives] are suitably ambitions" (p. 76); an objective "may increase clarity of our intention but it does little or nothing to improve its quality" (p. 78). The evidence in Chapter 6 contains cases in which different teachers' lessons on the concept of Density first began by giving pupils a definition of density which, as the syllabus document showed, was an attainment objective. Emphasis was mainly on the quantitative (i.e., technical) and not on the qualitative aspects of the concept. The same applied to introductions on the concepts of Mass and teaching on various Separation Techniques. Locating the issue in the context of similar research, the teaching to objectives approach contrasts with what Brown and McIntyre (1978) found in their study into the implementation of the Scottish Integrated Science in Scotland in the mid-1970s.

Their study, involving the staff of 50 comprehensive schools, concentrated on the correspondence between teachers' interpretations of innovations and those of planners (p. 19). Among their findings, they noted the relatively non-existent influence on teacher practice of instructional

objectives. Their findings are cited here quite extensively to facilitate ease of comparison with the case of the schools in this study. Brown and McIntyre state that:

In our context, for example, the curriculum planner had, for the first time in Scotland, specified a set of objectives for the course and specific objectives for each section of the work. Furthermore, they urged teachers to plan and direct their classroom activities towards attainment of these objectives, and to evaluate their own and their pupils' work in terms of attainment" (p. 21).

The main difference with objectives of the curriculum in this study is that teachers are not overtly, specifically, and directly directed to their attainment. But, the objectives define the curriculum and teachers were to use them as a basis for guiding both the scope of the content and pupil attainments. Brown and McIntyre's findings showed that:

The vast majority of teachers thought about teaching primarily in terms of content covered and their own or their pupils' classroom activities rather than in relation to objectives specified for the course. There was no evidence of ideological commitment against objectives among the teachers, the picture being more one of apathy explained by the fact that, while the course content and objectives had been specified, no linkage between recommended classroom activities, specific objectives for sections of work and general objectives for the course had been made explicit. Moreover, there was no explicit criteria for pupil performance in relation to the content that would enable the teacher to readily develop or select either formal or informal assessment procedures relevant to the attainment of the objectives. This appears to be a clear example of inadequate procedural specification (p. 21).

The picture established above is applicable to schools in this study save for the fact that schools in Brown and McIntyre's study had other support documents which helped operationalise the curriculum. But the apathy in the use of instructional objects (cf. Hamilton, 1973, 1975) and the inadequate procedural specification were manifest in different ways with the 26 teachers in Botswana who participated in the study. The specifics of the problem which comprise a second aspect of the teaching to objectives approach are discussed next.

The defining of the curriculum using instructional objectives only has assigned to teachers the role of the decision-maker regarding curriculum structure and approaches used. First the objectives did not appear to be based on an explicit view of learning; second, they were directly and mostly assessable on a one to one basis (cf. Bell, Jones and Carr, 1995, p. 91). But, with the teaching focus directed to attainment targets, the curriculum became *instrumental* to reaching certain goals and thus distorted the intrinsic value of the content and teaching processes (Stenhouse, 1985b, p. 81; see also Olson, 1992, p. 73). Holly (1977) defines *instrumentalism* as:

the elevation of the otherwise meaningless activities into worthwhile goals because of the rewards which successful performance brings ... great emphasis is placed on "marks". No one asks the worth of the tasks which are performed or whether they are educative: what matters is whether they can earn points. ... Learning is seen as a matter of ingesting pre-packaged ideas and information which demand an acceptance of both the moral and intellectual authority of teachers, headmasters and examining boards ... It [instrumental thinking] is also essentially alienated, separating the meaning of activity from the activity itself (pp. 181-182).

Examples of instrumentalism observed in the field include situations in which pupils were made to recite definitions, memorise tables, and record comprehensive teacher-made notes into their notebooks. The history of recitation as a pedagogic instrument is reviewed by Hamilton (1989, pp. 120-149). He sees it as some form of 'lock-step pedagogy' which is in conflict with the principles of individualised instruction. Stodolsky, Ferguson and Wimpelberg (1981) see recitation broadly, involving, as was observed in this study, a stand-up teacher using a "rapid-fire question-answer pattern of instruction" (p. 121). According to Pollard (1982) (after Westbury, 1973) the utility of recitation in teaching is found to enable teachers to "satisfy their teaching goal in spite of the practical and material difficulties which they often faced in the classroom" (p. 19). It suffices here to state that lack of teachers' guides and proper textbooks constituted the main material deficiencies within the teaching environment. This contrasts remarkably with the situation at the time Prophet and Rowell (1988) conducted their study. Teachers' guides, textbooks and worksheets were available and the completion-of-sentences and filling-in-of-worksheets teaching strategies were largely influenced by the materials provided. Hamilton's studies (Chapter 2) made similar observations. In this study, question and answer strategies are recognised largely as a consequence of teachers' desire to make the textbook accessible to pupils and to further highlight the key areas of knowledge pupils should obtain.

Further evidence of instrumentalism in teaching manifested in class reviews of concepts covered in previous lessons. The questions were at a level of recall, though, as one teacher said, "pupils learnt to forget". Notwithstanding the teachers' perception that the curriculum was 'cyclic', it was difficult to see how pupils realised that the revision exercises were meant to forge links between the previous module and the new one. Prophet and Rowell (1988) also had noted in their study on science teaching in Botswana that teachers placed emphasis on pupils giving correct answers. They also noted the widespread transmission of information via worksheets (p. 47) which formed part of the curriculum package. Prophet and Rowell also noted the existence of the difficulties of interpretation by teachers of the 'practical' (i.e., the curricula aspects de-emphasising academic education) component of the curriculum over the academic. Their finding is significant to this study in that while the curriculum then in use was a package complete with textbooks, worksheets, teachers' guides and a 'descriptive syllabus', that did not preserve the political rhetoric on which development of the curriculum was based. It would appear that the curriculum materials failed to capture the political aims. Similarly, the use of objectives in the new curriculum had

shown the same shortcomings (discussed later) though ideally the objectives made the curriculum more open to manipulation and interpretation by teachers. However, the objectives failed to give priority and emphasis to the main goal of the curriculum itself, namely, providing education for pupils set for senior secondary education and for those who will go into vocational education, self-employment, or to be a school drop-out.

As the evidence in Chapters 5 to 7 show, the rhetoric for preparing the youth for adult-life and for the world of work, necessarily symbolising the expressive role of the curriculum (see Bantock, 1977, p. 153), was less distinct and recognisable in teaching than was the academic and instrumental role and aims. The view of adult-life adopted here is similar to that of Rollnick (1998) in which basic science knowledge and principles relevant to application in daily life are taught so as to overtly influence pupils' attitudes and outlooks in life (see also Knamiller, 1984). Changing pupils' perspectives of life is consistent with the spirit of the 'expressive role' of the curriculum. The outlook should last a lifetime, save for situations in which it is superseded by more rigorous and/or higher understanding of phenomena. This constitutes a deep meaning of the curriculum which should ideally be captured in teaching, but which was missing. As Owen (1973, p. 80) has pointed out, the language of educational objectives seems to suggest that education had separable ends and that the curriculum was a separated set of means to those ends. Thus, it can be argued that the objectives promoted the instrumental over the expressive role of the curriculum and, more profoundly, that the two necessarily existed separately and had not been unified into a single entity in the implementation of the curriculum. In its pure form, science content retained its distinct identity in the curriculum. At the level of curriculum development, the situation highlights the attendant difficulties with the "retention of the orthodox curriculum but with an effort to introduce pupil activities and greater local relevance" (Sinclair and Lillis, 1980, p. 173). The point is explicated in the section on the accessibility of meaning of the curriculum to teachers.

As evidence clearly shows, the syllabus objectives syllabus did not concern themselves with the processes of teaching. They were content-oriented, thus influenced teaching divorced from the philosophical underpinnings of the curriculum. On the other hand, while teachers appreciated the expressive role of the curriculum, they appeared to have little sense of how it could be harmonised with the instrumental role. However, the intellectual returns to pupils of the teaching to objectives approach were unclear, since the pupils were found by teachers to be "forgetful". Hauwiller (1981) points to the possibility of conflicting expectations between mastery by pupils of the content covered and the mandatory coverage of the syllabus content. He notes that teachers typically cope with the situation by separating teaching goals and activities, with the former taking precedence over the latter. As in the case of Tobin, Espinet, Byrd and Adams (1988), who observed an 'exemplary' science teacher in the United States, the teachers' priority was to cover "work in scheduled time and to place the responsibility for learning the content with students" (p.

437). As one teacher in one of the eight schools in the study reckoned, pupils should do 90% of learning and his contribution was only 10%. That should be seen against the observed predominance of reading assignments and question and answer sessions in teaching. A syllabus expressed in instructional objectives influenced such teaching as was the case with mock examinations.

10.1.3 Examinations and teaching

In Chapter 8, teachers' accounts of the sample public examination papers showed that the papers were widely used for guidance and, invariably, as indicative of the standard to which concept development should be pitched. But the absence of regular school-based tests during the fieldwork does not help to show how the influence and guidance spilled over to other areas of teaching. The significance of the sample examination papers to understanding the implementation of the curriculum lies in the fact that they brought to the surface the priorities in the curriculum as seen by examiners. Thus, examinations influence teaching, regulate the curriculum (Watson, 1985, p. 156) and define both educational standards and educational aims (Lewin and Little, 1984). With the noted academic inclination of the sample examinations, their effect was of 'stereotyping' and 'narrowing' the main goals of the curriculum (cf. Owen, 1973, p. 26). As Owen explains, their effects on teachers are that they:

.. constrain him to watch the examiners' foibles and to note his idiosyncrasies (or the tradition of the examination) in order that he may arm his pupils with the kind of knowledge required for dealing successfully with questions that will probably be put out to them ... they predispose the teacher to overvalue among his pupils that type of mental development which secures success in examinations (pp. 27-28).

However, with the broad scope and depth of content coverage of sample examinations papers, it has been shown in Chapter 8 that they generated confusion among teachers, particularly regarding the reliability of the syllabus as a guide in curriculum implementation. On the other hand, the first formal public examinations of the curriculum were in November 1998, almost six months after the conclusion of the fieldwork. They confirmed the priorities or examinable areas of the curriculum as seen in the sample public examinations. The emphasis was in subject-matter content, concepts and principles. This pointed teachers in a particular direction emphasising the importance of content both in the implementation of the syllabus and in examinations. In the context of this study and in relation to the period of the fieldwork, teachers' interest in the examinations were partly due to the anxiety and the need to know more about the curriculum and thus feel secure in their practice (see OECD, 1973; Huberman, 1979). The sample papers were made available to schools following increased pressure from teachers.

As Dove (1983) explains, "the greatest challenge is to change the examinations so that they encourage new approaches" (p. 153) in teaching as well as in changing the content (Morris, 1986; Heyneman, 1987) by way of illustrating and exemplifying the main goals of the curriculum (cf.

Dreyfus *et al.*, 1985). Nonetheless, the possible impact of examinations on teaching is often ignored through the use of "examination technical specialists rather than education management specialist" (Heyneman, 1987, p. 260). The examination technical specialists "do not see the quality of classroom teaching as their responsibility" (*ibid.*). On the other hand, Rollnick (1998) aptly notes in general that "despite an interest by researchers, science educators and donors in promoting relevance in curricula, policy and examinations have yet to institutionalise this interest" (p. 85) (see also Lewin, 1990b, p. 48). This is true of schools in this study as the form and purpose of the examinations was clearly narrowly conceived. This resulted in what Scarth and Hammersley (1998) call "fact-transmitting teaching" .

One important aspect of the situation is the fact that the sample examinations were used by teachers as part of the wider strategies for operationalising the curriculum. They tended to give teachers what Fullan (1982) called 'false clarity' of the curriculum, as did the textbooks and syllabus documents which did not articulate with each other. In fact, both the examinations and textbooks occupied a rather ambiguous position in curriculum implementation, as they were not educative to teachers. It is suggested here that the accessibility of the meaning of the curriculum, together with the philosophy on which it is founded, should have been clearly embodied in and demonstrated by the structure of the curriculum itself and the associated materials. Here teachers' reliance on the materials is consistent with Wallace and Louden's (1992) debate on teacher 'coping strategies' (see Scarth, 1987; Pollard, 1982) that:

... confronted by new problems and challenges, a teacher struggles to resolve them in a way that is consistent with the understanding that he or she brings to the problem at hand ... Teaching therefore becomes a search for a more settled rather than a more effective practice (p. 508).

It appears that this is what teachers gained from their reliance on teaching to objectives and relying for teaching on textbooks and sample public examination papers.

10.2.0 Technical Procedurality Thesis

The arguments in this section can be articulated collectively within the technical procedurality thesis (Tomlinson, 1990, cited in Norton, 1994, p. 127). According to the technical procedurality thesis, emphasis is placed by teachers on doing and learning through action. Educational theories are not adequate to guide practice. The technical procedurality thesis is a response to the failure of Schon's technical rationality thesis which emphasises the "understanding of education through theories, concepts and ideas, which the teacher is asked to apply in the classroom" (Norton, 1995, p. 127). As Argyris and Schon (1977) note, teachers' "espoused theories and theories-in-use tend to be incongruous" (p. 147) and thus, theories do not necessarily precede action. On the other hand, while teachers' emphasis was on doing things well, Olson (1992) notes that the main problem includes curricula systems which "are incomplete upon adoption and carry with them significant meanings that cannot be known at the time of adoption, but which are important in the

long run" (p. 8) and could be of immediate long-term significance to teachers. This is where the technical procedurality thesis comes into the picture on curriculum implementation.

In this section on aspects of classroom environment, it is argued that teachers' concern with technical procedurality is noted in the common link between teachers' use of textbooks, the objectives-based curriculum and examinations where teachers were in search of focus in their teaching, hence in the implementation of the curriculum. In terms of the implementation of the curriculum, teachers' practice showed that the paradigm on which the curriculum is based was eroded and lost through difficulties in operationalising the syllabus, the use of inappropriate textbooks, and finally, through the content-oriented examinations. As Pedretti and Hodson (1995, p. 468) have observed, "teachers' concentration on 'how to' questions rather than 'what' or 'why' questions meant that more fundamental issues on teaching went uncontested". From Buswell's (1980) viewpoint, the apparent "contradictions in teacher's position stem from the fact that their own knowledge, skill and expertise have been devalued and yet they are expected to represent the embodiment of knowledge and expertise to pupils in schools and classrooms with hierarchical teaching relationships" (p. 304).

Furthermore, it could be argued that "only systemic change enables teachers to change" (Savage, 1998, p. 50) and that change in curriculum materials is inadequate to bring about desired curriculum change (Fullan, 1982). This leads to a conclusion that teachers probably could not intellectually access and operationalise the meaning of the curriculum. This symbolises the collapse of the technical rationality thesis and the rise of the technical procedurality theory in explaining teachers' behaviour and observed transactions in teaching. While both positions co-exist in any environment, the argument here is that the balance at the time of the study had shifted to the technical procedurality side. Also, the low technical procedurality has meant that the promotion in teaching of the expressive role of the curriculum suffered. The next section picks on the debate.

10.3.0 Accessibility of the Meaning of the Curriculum

Following from the discussion suggesting that teachers were in search of focus in their teaching, this section continues the debate by focusing on clarity and accessibility to teachers of the meaning of the curriculum. Two areas are chosen for illustration. One is on the incorporation into science teaching of examples from the pupils' environment (i.e., out of school experiences); the other focuses on pupils studying the curriculum. The justification for concentrating on the two areas is that they both shaped teachers' decision-making and management of classroom activities. Also, Chapter 5 contains teachers' accounts, supported by empirical observations, showing teachers' difficulties with the two areas. The constructivist thesis on learning and the sociological concept of egalitarianism are used to conclude the section.

10.3.1 Pupils' immediate environment and science teaching

Both empirical classroom observations and teachers' accounts illustrated difficulties teachers faced in integrating examples from pupil's environs into science teaching. The difficulties took different forms. As some examples in Chapter 6 showed, some teachers were not conversant with how to handle the pupils' out of school experiences. Some teachers were alienated from their classes as they did not share perceptions and interpretations of phenomena with their pupils. For other teachers, by their admission, examples from the environs were used infrequently and mainly for illustrative convenience. The varied positions noted pointed mainly to the issue of understanding the place within science teaching of pupils' environment and elements from it. The issue is explored in a wider context of literature on science teaching.

As is commonly held in education, a child internalises the value system, the culture and societal norms, the language and ways of interpreting phenomena specific to the society of which s/he is part. This gives a child a certain predisposition to learning (see, for example Baez, 1972; Datta, 1987) which Logsdon, Taylor and Blum (1988), citing Rupp (1969), calls the 'cultural pedagogic' tools or activities. According to Tsuma (1985), "the appeal to the immediate environment with which the students have familiarity has the distinct advantage that it is *ipso facto* an appeal to the students cognitive structures" (p. 48). This view has some basis both in Piaget's and Ausubel's psychology (see Rollnick, 1998; Newton, 1988). As Newton states, incorporating pupils' out of school experiences is "commonly seen as having strong motivational value and to hold promise of enhanced learning, retention and recall of what has been taught" (p. 8). The political value and appeal of teaching science, in Botswana and in other developing nations, which does not alienate pupils from their culture, norms and societal values is also high. These issues are widely acknowledged in literature. See for instance, George (1999), Yoloye (1998), Jegede (1995), Glasgow and West (1988), Boorer and Preston (1987) and, Buseri (1987).

In this study pupils provided several experience-based examples which were relatively amenable to the application of conventional science. As evidenced in Chapters 5 and 6, teachers failed to engage pupils in attributing meaning to their experiences. This difficulty has been widely acknowledged even in the United Kingdom. As Mayoh and Knutton (1998) stated:

... our data did highlight the relative sparsity of episodes involving out-of-school experiences in lessons observed; episodes were less frequent and of shorter duration than had been anticipated at the outset of research. This was even true of those teachers who purported to base their teaching approach upon linking pupils' everyday experiences to science learning (p. 627).

The observation raises two interrelated issues. One issue is somewhat rhetorical and relates to what knowledge and pupils' experiences were worth considering in science lessons. It is answered by the second issue which focuses on teachers, in particular, the nature of experience-based

contributions accepted from pupils and those examples that teachers themselves gave. They are taken to embody the meaning teachers gave to the curriculum.

Chapter 6 contains examples of situations in which teachers supplied meaningful but alien examples to pupils. One such example is of tidal motion; another is on the use of satellites for communication; while the other teacher gave an example drawn from a TV news item. Still, there was another teacher who gave examples of the solar water heating systems, the thermos flask and a typical car engine cooling system, stating that the examples were listed in the syllabus document. The extent to which teachers saw the examples as appropriate and meaningful to pupils is questionable. Their effect was to alienate the pupils from both the information that was being transmitted and from the teachers themselves (cf. Boorer and Preston, 1987, p. 13). Part of the evidence for this is in the observation that neither teachers nor pupils asked questions relating to examples. Pupils simply noted the examples down in the science note books. Quite clearly, the items were within the realms of teachers' knowledge and experiences. Paradoxically, teachers often drew real-life examples from textbooks. For instance, this was the case in all the observed lessons on the ecosystem and in those on heat transmission and separation techniques. Thus, textbooks as sources of information were taken as prescriptive and dogmatic rather than as giving guidance to both teachers and pupils (cf. Oakley, 1993), further alienating the pupils from the knowledge.

This pointed to two key fundamental problems. One was the pedagogical problem which, as discussed earlier, was content oriented or, more specifically, "science-centred" (Newton, 1988, p. 9). The issue here is that of the accessibility of meaning and of understanding the position of the examples in teaching. The accessibility of meaning of curriculum is grounded in the functional view that the out of school experiences pupils gave were for their personal development as well for their immediate and long-term use. As Boorer and Preston (1987) found with teacher effectiveness in (higher) education in developing countries:

... many teachers are unable to perceive the state of readiness of their own students to receive information they are about to transmit ... This is because of their ... inability to project themselves back to a point that preceded that experience; at the same time, students are unable to penetrate the mystically clad words of their teachers because of the own restricted experience, either in the content of the communication or of the style in which it is being transmitted (p. 14).

On the other hand, rather paradoxically, the answers that teachers sought from pupils were not only expected to be in proper scientific prose, but were expected to be consistent with the perception of phenomena held by teachers. Three examples from Chapter 6 are used to illustrate the latter point. In one case, a pupil's explanation that a crocodile basking in the sun symbolised adaptation to its environment was rejected by the teacher. The other case is of the pupil who said humidity in the atmosphere is low when the sun is shining. The third example is of a pupil who

said solid matter floats in septic tank because it is lighter than water. The three responses were rejected - neglecting both the plausibility and ingenuity in them - by the respective teachers who, in turn, supplied scientific versions or explanations. Prophet and Rowell (1988) too noted a similar problem in their classroom observations in schools in Botswana. They explain the phenomenon thus:

... this technical language is widely used to 'explain' concepts, whereas in reality all that happens is the production of a conceptual 'fog' which blankets everyone, sometimes including the teacher. ... As well as the conceptual confusion sown, two messages are being conveyed to class ... First of all that there is a special form of language which is 'superior' to the everyday common-sense language used to describe things and events. Second, because the teacher has access to this language he now has the authority to both pass on the language and associated technical information and also declare other ways of describing reality as less valid (pp. 28-29).

This points to a dilemma in that understanding of the events has to be scientific and achieved through rules and definitions while teachers risked sidelining pupils experience-based contributions. It is also a dilemma affecting empowerment of pupils which Atwater (1994), citing McLaren, defines as the "process by which students learn to use critically science knowledge that is outside their immediate experience to broaden their understanding of science, themselves, and the world and to realise the prospects for reforming the accepted assumptions about the way people live" (p. 569). At this point it is worthwhile to briefly consider other views which do not necessarily blame teachers for science-centred teaching and explanations.

One argument is that "the place of science in the school curriculum is secure and its status is high" (Woolnough, Allsop and Nash, 1985, p. 210). The status, "coming from its links with the scientific establishment beyond the school" (and society in general), they argue, can inhibit implementation of any change and science teaching moving away from traditional methods. The second argument focuses on the syllabus itself. Newton (1988) suggest that, "there is a strong belief in the value of coherence and unity of knowledge for rational action" (p. 8). But, the science curriculum and its contents tend to represent the logic of scientific disciplines and neglects the goals of science in contemporary life (cf. Weber, 1985). This compromises the balance between the disciplinary and utility value of content in the realisation of the goals of the curriculum.

In terms of curriculum, the shift in emphasis away from the generality and coherence of the theoretical knowledge of integrated science as a discipline, and towards the functionality and relevance of the knowledge in everyday life, is not built into the curriculum itself (cf. Lijnse, Kortland, Eijkelhof, Genderen and Hooyemayers, 1990). Apart from the curriculum failing to guide teachers, it remains to be seen if teachers attached any academic value to the whole science curriculum itself. So far, it is abundantly clear that the pedagogic advantages of using out-of-school experiences in science teaching have not been realised in and through teaching. There also

exists a complex question of what the curriculum stands for; the depth to which an explanation of phenomena should be taken; and the framework within which deliberations should be conducted.

As Chapman (1986, p. 123) explains in a UK context, knowledge as defined by a school excludes the everyday, 'common-sense' knowledge possessed by pupils, brought with them from their homes. The knowledge and use of technical language by teachers evidently represent a 'cultural-pedagogical' dimension that teachers bring to class. To paraphrase Wolfe (1989), the ability to use appropriate vocabulary to communicate ideas is characteristic of teachers (and scientists) influenced by a rational view of science. By extension, it would seem that teachers, science teaching and invariably the implementation of the curriculum have not been absorbed into the socio-economic environs in which schools are located. Borrowing expressions from Hall (1977), describing the position of 'urban schools' in 'working-class' neighbourhoods in England, it can be said that:

In terms of vertical networks, this school had quite other connections, served other purposes, was serviced and administered by quite different people. It stood, in essence, for value, for kinds of learning, for types of discipline and authority, it affirmed experiences altogether at variance with its natural environment ... This mismatch between where the schools stood, and what they stood for, was always a glaring one - part of a larger contradiction (pp. 12-13).

If teachers are to consolidate the position of out-of-school experiences in their teaching and, hence, to show that they have accessed and operationalised the meaning of the curriculum, then perhaps they should adopt orientations akin to those of an "alert social scientist who has thorough local acquaintance" (Campbell, 1975), or, as Whyte (1984) thinks of a sociologist, that a teacher should have "first, intimate, habitual, intuitive familiarity with things; secondly, systematic knowledge of things; and thirdly, an effective way of thinking about things" (p. 282). In terms of Logsdon *et al.*'s (1988, p. 25) explanation of the influence of 'cultural-pedagogical' activities on learning and in view of the predominantly generally weak use of out of school experience and those alien to pupils and not their teachers, it can be said that cultural-pedagogical activities are those activities which teachers structure for their pupils to invite pupils' interaction with cultural materials comprising teaching resources. The degree of this interaction is possibly also largely determined by socio-economic status and influenced by teachers' own experience with these activities. Furthermore, it would seem that teachers and pupils from different socio-economic milieus are unable to draw fruitfully upon a cultural-pedagogic tradition unless a common and responsive ground is found and established (*ibid.*).

If the out-of-school experiences are viewed as related to socio-economic factors, then Newton's (1988) position on the matter is appropriate:

... if the ways in which science was relevant to someone from a lower social stratum were found to be different to those from a higher social stratum, should science education reflect the difference? If it did, it might serve to reinforce the class structure, an outcome some would find indefensible. Yet in allowing pupils to see its direct relevance to their lives there is that risk. ... The dilemma is that, giving consideration to the students' present and future needs would make for relevant science teaching but risks overly reinforcing class and cultural divisions (p. 9).

The argument is discussed briefly in two contexts: the curriculum, and the wider society in Botswana. First the difficulties Newton refers to reveal dilemmas in developing curriculum in a country with approximately 80% of the population in rural areas and 20% living in urban centres. The urban centres, symbolising modernity or modernisation, are relatively highly industrialised, cosmopolitan and inhabited mostly by the rising middle-class. They are the pride of the nation and offer an alternative way of life to the rural masses. The rural countryside, on the other hand, while it has its advantages by way of its lifestyles rich in their own way, particularly the respect for traditional cultural norms, might be seen as impoverished in technological advancements and as generally backward.

In terms of occupations and status, teachers belong to the middle-class and may be alienated and disenfranchised from the immediate environs to which science teaching should relate. However, this might not be as big a problem as the dilemmas arising from the curriculum itself. The discussion (Chapters 6 and 7) showed that out-of-school experiences, while seen as a factor in teaching, were also seen in a negative light. It is noted in the syllabus that "some of these experiences may become useful or inhibitive during the teaching/learning process, and so teachers have to be aware of these earlier experiences to more effectively communicate understanding through recognising individual abilities, interests and needs" (Ministry of Education, 1995a, p. i). The implied separation in the curriculum and in its implementation of science from non-science could easily transform to middle-class and peasant virtues or to urban and rural education in a country with a highly skewed population and wealth distribution.

The other dilemma of the curriculum is in the futuristic and transformative ideology espoused in the curriculum. There is a tension in a curriculum which seeks to locate its implementation in the wider social contexts, while at the same time carrying futuristic goals of preparing the youth for participation in technologically advanced 21st century Botswana. It is a tension between the conservative and the futuristic goals of the curriculum. Teachers in rural areas where a television set, a satellite receiver and solar water heating panels easily pass for alien items have a practical difficulty in striking a common ground between the conservative and futuristic goals of the curriculum.

In terms of change theory, mutual adaptation (Fullan, 1982) of curriculum to the wider environs, encompassing teachers, pupils and institutional contexts, has not been easy to realise in the schools in the study. This is so despite the seemingly accommodating philosophy which guided the development of the curriculum. It has not been possible to identify the root cause of the problem. Three speculative explanations are presented. As Lynch (1997) and Olson (1992) suggests, teachers have relatively less interest on the philosophy of the curriculum than in the textbooks and other associated curriculum materials. Another view is that there could be a mismatch between the ideal curriculum and the teachers' perceptions and ideologies of the science curriculum and its teaching or, rather, the 'pedagogical code' of the school (Hoyle, 1975, p. 336). It should be emphasised, however, that the impact of teachers' beliefs on curriculum implementation did not appear to be an issue here. If there were any impact, it originated not from the curriculum content *per se*, but from how to teach it. The other view is that the utilitarian use of science as a vehicle or a means to an end (i.e., to political ideals of basic education) while at the same time recognising the teaching of pure science as a legitimate task in its own right (i.e., of intrinsic worth) is problematic. As a means to an end, teaching science is perceived thus:

... the role of school science is to take pupils beyond their everyday experiences and ways of knowing and talking about the world. School science should provide pupils with the ability to make use of scientific ways of viewing the world around them, whilst taking care to provide appropriate and carefully constructed links with their everyday experiences (Mayoh and Knutton, 1998, p. 628).

Pedretti and Hodson (1995) explain this to mean "ensuring that learning is rooted in the personal experiences of individual learners" as well as "ensuring that students have opportunities to confront issues that have a scientific, technological or environmental dimension" (p. 465). Furthermore, as Atwater (1994) states, "students' power involves them in judging more effectively when to use their science knowledge and skills" (p. 570). Conversely, teaching pure science for its intrinsic worth was such that teaching appeared to avoid the challenges posed by the integration into science teaching of out-of-school experiences. However, the difficulties demonstrate that the science curricula was based on a "rather different concept, educationally and socially, as far as the teaching of science and its objectives are concerned" (cf. Zoller, 1985, p. 78). As George (1999, p. 77) would say, the curriculum was not fashioned from a "cultural perspective" and did not help teachers to merge or integrate successfully out-of-school experiences with science. However, the evidence available suggests that teachers were rather uncertain of the place of out-of-school experience in teaching which, by implication, suggests an area of difficulty in implementing the meaning of the curriculum.

10.3.2 Mixed ability pupils

This section continues debate over the accessibility of meaning of the curriculum to teachers. It is argued here that pupils supplied to follow the curriculum are an indicator of the meaning given to the curriculum. And, it is in the process of teaching that the accessibility of the meaning of curriculum and its operationalisation with a particular group of pupils become apparent. Data from classroom observations, interviews and policy documents are used both as a basis and as evidence in the discussions.

As shown in Chapter 7, teachers expressed dissatisfaction with the abilities of pupils following the science curriculum. The main basis for their dissatisfaction was pupils' achievement at Primary School Leaving Examinations (PSLE). Data from classroom observations did not contain instances which conclusively showed activities that could prove or otherwise the match between pupils' abilities and those required for the effective implementation of the curriculum. However, instead of seeing pupils as an intrinsic weakness preventing full realisation and proper fulfilment of the ideals of the curriculum, it is argued here that teachers' views of pupils shaped the management of classroom activities; hence, giving the curriculum-in-action a meaning. For instance, as explained in Chapter 7, and following from evidence from classroom observations, it has not been possible to identify any particular group of pupils which was targeted in teaching. Furthermore, the structuring of lessons themselves failed to form a coherent basis for understanding the meaning teachers gave the curriculum. Some teachers have pointed to pupils as the source of the problem.

At least half the number of schools in the study planned to mount *remedial lessons* outside normal schooling hours. Ironically, the lessons were to involve all the pupils. The observation constitutes part of the evidence of implementation of curriculum separated from the pupils it was designed for. For, if the curriculum were designed for a mixed ability group, which is duly supplied through automatic promotion within the basic education system, then the group should be catered for well within the normal teaching sessions. But it would seem that lecturing, whole class teaching and recitation - forming the core of observed classroom management and pedagogic strategies - glossed over the needs of the individual pupils in any given class. Pupils' needs were also not catered for in the few instances in which practical sessions were initiated. Pupils' manipulative skills, as was the case in Prophet and Rowell's (1988) study, were underdeveloped as Chapter 6 shows that data collection and completion in time of practical activities in a highly co-ordinated setting, was the norm.

The teaching strategies embodied two main strands of teacher control over pupils. One is *domination* (Stebbins, 1981, p. 248; Woods, 1979, pp. 150-153) particularly noted with teachers of low ability pupils. In this study, question-and-answer sessions predominant in teaching

indicated high teacher control of class content and of intellectual acts which pupils needed to develop. There is maintenance of 'role distance' wherein 'teachers try to keep an emotional and personal gulf between them and their pupils' (Stebbins, 1981, p. 248 after Lacey, 1970). According to Stebbins and Woods, classroom routines serve as a means of control, helping to pace the activities of the classroom while providing scant opportunities for contributions from pupils to be made and utilised. Here lies a dilemma. First, teachers might have failed to cater for pupils on account of their limited or lack of understanding of strategies for teaching the syllabus. In fact, the syllabus does not specify any particular instructional strategies to be followed. Second, teachers have probably made an assessment of the possibility and viability of mixed-ability teaching which, in light of their professional judgement, was not feasible with the pupils. As one teacher said:

.. the quality of the input from primary schools is low ... the syllabus is no doubt a long tale. Here and there we have pupils who cannot write their names, or even speak their names and to them, it is a conflict, a challenge to the teacher to handle such a long syllabus. When we look at the government, it aims high, and we see that every community would like to see its 'kids' know more and more. It is a good thing. But currently, it is not pragmatic to have this lengthy syllabus to the sample which we receive ... I see it as challenge to a teacher - transformation of student from low to high level ... it is a tough situation.

(Mrs, Interview, Phase 1, File 7)

One account in my diary reads:

Miss K has observed that the ministry advocates for mixed ability teaching which, she says, calls for the differentiation between pupils and therefore differences in teaching of students in the same class. However, the syllabus itself does not show how this should be done; teachers have difficulty in knowing how to do the differentiation, in particular, what should be done to teach 'the same topic and to the same objective' to pupils of diverse abilities.

(Kal, Discussion, Phase 1, File 11)

While teachers' perceptions and accounts of pupils have to be treated with caution, as they may be based purely on teachers' observations of pupils' behaviour (Furfey, 1965, p. 478) and teachers' expectations of their pupils, there are important lessons to be learned (see also Furlong in Woods, 1992, p. 357). It is such specialist knowledge, expectations and posture which leads teachers to adopt a 'fatalistic attitude' (see Chapman, 1986) towards both the pupils and the curriculum. The two accounts above are evidence of attitudes which defeat the purpose of the wide ability enrolments; hence, the philosophy of basic education. Teachers viewed the curriculum as providing inadequate guidance about teaching the syllabus to the pupils and there was a general view that pupils themselves lacked motivation. As one of the above accounts shows, some teachers were influenced by both the PSLE results and the very fact that some pupils had extremely low numeracy and literacy skills.

The contention here is that such teachers' attitudes toward pupils create a dilemma. First, teaching seems to perpetuate the disadvantaged position of some pupils. Second, and in view of the additional evidence that no classroom activities teased out and exploited the abilities of pupils, and the manner in which new Form 1 recruits were inducted into science teaching questions arise regarding claims, for instance, by Prophet (1990) and Buseri (1987), that the wider social culture under which pupils were born and raised militates against the teaching of science. Third, the meaning teachers afforded the curriculum did not become apparent during the process, particularly that pupils were 'missing' from the centre stage of teaching, or rather, occupied a loosely defined position in the implementation of the curriculum.

There are two aspects of the problem. One is that teachers were more concerned with the goals (content coverage and attainment targets) than with the means to realise them. This is evidenced by the fact that the repetitive nature of the syllabus which was, ideally, to take the material to different depths of understanding was not performed by teachers in a manner which permitted a coherent cumulative development of understanding and skills in learners. The second dimension of the problem is that the curriculum itself lacked precise focus. This issue has been raised variously in this chapter but here the point is that the curriculum does not centre on the pupil *per se*; neither does it carry an explicit structure of relevant curriculum. It is rather indeterminate. As one teacher has already noted, the lack in the curriculum of the differentiation between students' ability to learn means that it is not clear whether or not diverse learners and their abilities were developed in the curriculum. The problems inherently lie at the meeting point of state politics and education: some of the difficulties in teaching are borne of the political control and vision of education held by the government.

As explained in Chapter 1, basic education in Botswana spans both primary and junior secondary education. Since 1993, progression rates between the two levels have reached 93% (Republic of Botswana, 1993) as academic achievement at PSLE became subsidiary to wider access to education. Examinations, where available vacancies for new entrants at CJSS permit, were not a tool for selection. The arrangement has created four interrelated problems for science teachers at CJSS. First, universal access to basic education is a primary political aim such that basic education has become a rite of passage for nearly all children of appropriate schooling age. The problem here could be the fact that some pupils are 'parcels' in basic education as they are in schools without a clear sense of purpose and direction. As explained above, this creates a challenge for teachers. Second, what is clear is that equality of opportunity and access among pupils is deliberately not intended to lead to equality of outcome. As stated in the syllabus document:

... the science syllabus is designed to cater for students who will proceed to senior secondary education or vocational training and those who will leave at the end of form 3 for the world of work (Ministry of Education, 1995a, p. i).

This is government-sanctioned and led socio-economic determinism. It is an official fact and documented reality that all the three groups have a worthwhile place in the socio-economic and political milieu in Botswana. Here the goal orientation of the curriculum also lacks precision of focus. Okada (1999) reports similar observations in Japan.

Okada raises several insightful points which can help illuminate the problem in Botswana. The widespread agreement that equality of opportunity is a fundamental requirement in modern Japan is noted though Okada notes, "there is also widespread disagreements about just what this requirement amounts to and how it is to be balanced against other requirements such as 'meritocracy'" (p. 71). The disagreements have not yet surfaced intensely in Botswana for two reasons. One is that advancement in education has traditionally been linked to performance in examinations. The second reason comes from the fact that ones' access to and progression in education is politically controlled and this is not known to the public at large. The National Commission on Education of 1993 has called upon the government to remove the bottlenecks which are based on manpower requirements and pyramidal structure of society. This restricts access to senior secondary and tertiary education. Okada also distinguishes usefully between "meritocratic" and the "egalitarian" concept of equality of educational opportunity:

... while the meritocratic concept of equal opportunity focuses on the possibility of the same access to schooling, the egalitarian focuses on that of the same educational achievement in school. The egalitarian view assumes from the start that elimination of early selection of those judged to have low academic ability will not be sufficient to ensure equality of opportunity. ... Based on this view, the egalitarian interpretation tends to place greater emphasis on a "unified" education system, such as comprehensive school (p. 175).

The notion of basic education, with its non-discriminatory and automatic promotion between primary and CJSS, is consistent with Okada's view of egalitarianism though progression to senior secondary education is based on merit. Rather insightfully, regarding egalitarian education, Okada notes that:

However, equality of opportunity is defined not as being content of schooling, teaching methods and curricula, but as optimal opportunity to develop fully children's personal ability ... Thus, in the egalitarian position, the principle of individuality is much more important than a consideration of national efficiency or the needs of economy. It differs significantly from the meritocratic position in its view of the relationship between education and the wider social and economic structures (pp. 175-176).

That equality of opportunity is "defined not as being content of .. teaching methods and curricula" seems to be true of the curriculum in this study, though the position does not help to clarify the science curriculum's position, role and status in the overall school curriculum. The meritocratic aspects of the curriculum lie in preparing some pupils for senior secondary education, while the less fortunate will go into vocational education, or face the grim prospect of being a school

dropout. Tournas (1996) captures the school-leaver's problems in Botswana since the first relevant curriculum was used in 1986 to 1995. His position will not be repeated here. However, Okada's view that an egalitarian system is on development of the individuality of the learner do not hold in the context of schools in the study. What is the case and given high priority in Botswana is the efficiency of the national education system and the meeting of the country's needs. This leads to the continuation of debates on problems that basic education has created for science teaching at CJSS.

Third, the widespread concern with grade 'D' pupils, with some teachers suggesting that they need special education, while some schools contemplated remedial teaching, is symptomatic of catering for diverse ability groups within the undifferentiated set up of mainstream education. However, Fantini (1981, p. 216) locates the blame on teachers and contends that viewing pupils as either 'winners' or 'losers' (i.e., slow learners) has led to a self-fulfilling prophecy in which the losers have further been classified as people who simply cannot learn. "The policy of providing remediation and cure, rather than exploring prevention", he states, is a shortcoming of the school system. Fourth, and related to the latter point, there exist a tension within teaching in basic education regarding what primary schools and CJSS stand for, individually and collectively. For, if not all pupils from primary schools are found teachable at CJSS, then chances are that education at the two levels do not combine well with each other (see Republic of Botswana, 1993). Or, if they do, then the philosophy of basic education is not used favourably by teachers in dealing with pupils at CJSS.

What has become clear is that while the political and symbolic meaning of school enrolment appears clear, it has been at the cost of blurring the meaning of the science curriculum. This points to one of the paradoxes of relevant education programmes. As Sinclair and Lillis (1982) have observed about third world countries, "there has been recurrent tendency for policy-makers and opinion leaders to look hopefully to schools as agencies which would contribute to the solution of social and economic problems of the times, whatever they believe these to be" (p. 32). On the other hand, however, the instrumentality of teaching discussed earlier and the dichotomy in the school curriculum arising from it comprising traditionally academic subjects as the core curriculum and the electives, comprising conventional vocational subjects, it can be argued that the situation possibly predisposed teachers to see science as a purely academic subject. If such an argument can be sustained, it can be said rather tentatively that "it was difficult to conclude anything but that the needs of those who would continue in school were given greater emphasis than those of school leavers joining the labour force" (Lewin, 1990d, p. 195). Personal and intellectual development of the would-be school leavers (the unemployable) appeared to have not received attention either.

10.4.0 Constructivist and Egalitarianist Perspectives

The discussions on accessibility of meaning of the science curriculum generally fall within two separate frameworks: the constructivist thesis and the sociological position of egalitarianism. The constructivist thesis whose notable proponents include Ausubel and contemporary science educators such as the Late Rosalind Driver holds that any new information is seen in light of existing schema of knowledge, concepts and experiences. The view has been influential in re-conceptualisation of modern teaching and learning both in developed and developing nations. Nonetheless, there has been mounting evidence that the constructivist thesis as conceptualised in developed nations needs to be adjusted to suit situations in the schools in the study.

The literature shows that understanding the behaviour of pupils in the classrooms in cultural terms is made difficult by evidence suggesting that pupils tend to keep the world of school separate from their cultural worlds. Using the concept of 'collateral learning' and 'the eco-cultural paradigm' to explain the ideal-real curriculum gaps noted in science teaching in Africa, Jegede (1995) makes the following observation about the learner: "this 'good' scientist at school can at home be a 'traditionalist' without any feeling of cognitive perturbation or dissonance" (p. 350). This view is similar to those findings based on constructivist ideology in which world views of learners or alternative frameworks have proved resistant to change (Driver, 1989; Solomon, 1987). The two worlds an African pupil operates in are also noted by Rollnick (1998):

The student in Africa has one name which is used at school and another one which is used at home. There is one type of acceptable behaviour at school and one at home. There is one type of dress at school and one for home. There is a language for school and a language for home. Because of this, the student, too, becomes two people. Why not two concepts of science? (p. 86).

The picture painted above hazards caution at any interpretations of classroom transactions which do not acknowledge the complexities of linking those transactions with the lived experiences of the pupils themselves.

In this study, the fact that teachers, as some examples in Chapters 6 and 7 showed, were alienated from pupils and their that conception of everyday phenomena suggests existence of what could be called *collateral teaching*. Here the teacher inhabits and operates in an exclusive world of science where only formal definitions, concepts and rules are recognised. This temporarily shuts out pupils' intuitive and widely held views on phenomena. This poses a challenge to the constructivist thesis. First, the worlds of science and non-science have to be reconciled in teachers themselves. Secondly, the main question is not only that of how to reduce alienation between teachers and pupils, but of what images and scientific and teaching conceptions should be given the teacher. The dilemma here concerns how to move teachers from positions of being specialist and experts (in teaching science) yet retain the power to manage classrooms and to live positively within them

and with their learners. It appears that this dilemma has not been highlighted before and, most importantly, through a study which was not conceived within a constructivist position. The dilemma is evident and very significant in disagreements between teachers and pupils over meaning and interpretation of phenomena (e.g., river, water vapour) common to both camps. The other significant aspect of the dilemma is that while teachers and pupils shared the same native language, in most cases it was not used as a vehicle to resolve disagreements and make learning meaningful to the learners.

However, the fact that enrolments of pupils of wide abilities is perceived to cause difficulties in understanding the meaning of the implemented curriculum evokes arguments from the sociological thesis of egalitarianism as it applies to the notion of basic education and relevant education for Botswana. The egalitarian thesis and how it is applicable to the situation has been explained earlier in this chapter. Here Bantock's (1979) observation suffices to summarise the position of the thesis in explaining curriculum implementation. Bantock aptly noted that there could be a conflict in reconciling egalitarianism with the maintenance of academic standards by schools and teachers. What this study argues is that the meaning of the curriculum was blurred in the process particularly as teaching went on in undifferentiated (non-streamed) classes.

In brief, this section has argued that the meaning of the curriculum-in-action has been relatively unclear due to the ill-defined cultural-pedagogic activities, the political and symbolic functions of the school enrolments within the basic education set-up. Furthermore, priorities which lie within the scope of the rhetoric of the curriculum are vague and of no utility whatever in terms of guiding teacher practice. The teachers' call for a teachers' guide (Chapter 7) to be made available is seen as their response to the lack of procedural clarity (Brown and McIntyre, 1978) regarding the direction and purpose of the curriculum. "Absence of procedural referents may introduce a substantial barrier to implementation", asserts Brown and McIntyre (1978, p. 21). But quite clearly, the purpose and meaning of making science relevant and intellectually accessible to all pupils has been lost, first in the curriculum then in teaching. The constructivist and egalitarianist positions as argued above, support the assertion.

10.5.0 Summary

In this chapter, the interpretation of findings considered two interrelated areas of implementation of change. The areas are: a) aspects of the teaching environment, and b) accessibility of meaning of the curriculum. The main emphasis in the discussions in each section was to place the research findings in the wider context of the literature on educational change.

The main theme which emerged is that the implementation of the curriculum was constrained by the teachers' understanding of the curriculum itself. Teachers relied heavily for guidance primarily on mock examination papers and on obsolete textbooks. Furthermore, teachers have

been rather uncritical in interpreting their roles in change implementation. Thus their teaching repertoire of skills and knowledge have been under-utilised so much so that teachers were seen as relatively de-skilled by the curriculum change. As Denscombe (1980) argued, "1) routine teacher activity constitute a practical response to perceived exigencies of the situation, and 2) that these exigencies can be attributed to particular organisational arrangements" (p. 279). Attention is drawn to the provision of textbooks and sample examination papers which signify problems with the management of curriculum change. As Dyer (1999) notes, "misjudging the ease of policy implementation is recognised as one of the most common planning mistakes. If implementation is not planned and structured, effective management of change may give way to ad hoc adjustments and short-term strategies for coping, with the subsequent dilution of policy efficiency" (p. 45).

Overall, there are many factors which crippled the implementation of the curriculum. But there were two fundamental ones. As Savage (1998) notes, a pre-requisite for successful change is that "curriculum goals, materials, teacher support services, syllabus and examinations must not be in contradiction" (p. 41). This golden rule was not met in the schools in the study. The second factor was that the curriculum itself did not carry any authority from which teachers could derive support, guidance and with which they could proceed to implement the curriculum. For instance, there exist a lack of coherence in structure of the curriculum, absence of appropriate pedagogic methods, and lack of clear rationale for change. The next chapter shows how the wider organisational environment was a factor in teaching. This helps ensure a fuller understanding of how various socio-political factors shaped the curriculum upon implementation.

CHAPTER 11

MANAGEMENT OF CHANGE

This is the second chapter in which research findings are interpreted. In the first, Chapter 10, discussions focused on the implemented curriculum as perceived in the context of classroom environments. This chapter goes a step further and considers how the curriculum was managed within the wider organisational environment. The term 'manage' here refers to the handling of the curriculum and the roles played by various agents, bodies and groups of people in the implementation of the science curriculum.

The primary justification for considering the handling of change within the wider organisational environment is that some aspects of the latter emerged in every teacher's account as inseparable from their classroom practice. That indicated that teachers saw their practice as influenced by factors beyond the confines of the classrooms. The evidence in Chapter 8 indicated teachers' concern with both the level and quality of professional guidance rendered to them by the Ministry of Education. The role ambiguity in implementation of the curriculum of school management teams was also highlighted. The evidence also pointed to low or non-existent collegiality amongst science teachers such that idiosyncratic approaches to universal problems of curriculum implementation prevailed.

The issues fall into two broad areas viz.: management of change in the wider organisational environment and the teachers' role in change implementation. The issues are considered under four sub-sections: a) the organisational environments in schools; b) collegiality amongst science subject teachers, c) roles of the Ministry in curriculum implementation and, d) teachers' role and positions in curriculum implementation. The discussions are placed within the wider literature on the management of change. The eclectic discussions are finally viewed from certain theoretical perspectives on curriculum change.

11.1.0 Organisational Environment in Schools

The evidence in Chapter 8 indicated that the schools in the study did not have a leader in charge of managing change. Curriculum "experts" were based at the Ministry. The section focuses on this anomalous situation and tries to give a detailed insight into the problem.

11.1.1 Leaders in change management

The literature on implementation of change suggests that the mere introduction to schools of curriculum materials is not a sufficient condition to ensure its uptake by teachers (see Olson, 1992; Wise, 1977). As Woolnough *et al.* (1985) noted in the study of dissemination of curriculum through documents in Oxfordshire that the acceptance of the documents "rarely had sufficient

effect to cause a change to the existing curriculum unless there already existed in the school a dissatisfaction with the existing science programme" (p. 210). In addition, House (1979) and Earley and Fletcher-Campbell (1989) see having an advocate(s) of change within schools as a prerequisite for its effective implementation. Also, Havelock and Huberman (1977) in their model envision curriculum change as a formation of a new social system and call having a leader a 'precipitating condition' for change: "thus the leader is a convenient symbol, and the emerging state can be imagined to be a reflection of the coherent design which already exists in the leader's mind" (p. 38). In perceiving 'system creation' as prerequisite to implement innovations, they state that:

... first we need to imagine what it is like to have no system; then we need to respect the difficulty of bringing the stable and functioning systems into being, starting from being scattered, disparate and often competing and warring elements ... Essentially, a system can be said to have been created where there are numerous and persisting interconnections among members and groups: when there is cohesion in the form of shared identity observed, agreed, and/or obeyed norms, rules, procedures and laws; when there is a focus of concern and constructive action on common needs, especially for basic survival and mutual security (Havelock and Huberman, 1977, p. 39).

The above citation suggests the reason why having a leader is a "precipitating condition for change". The emergence of a leader was particularly necessary in the schools in the study as the curriculum was developed outside schools. Having leaders on site could have served an important role in developing a sense of 'problem-solving adequacy' (see Huberman, 1979; Hoyle, 1975) amongst teachers in a school. It is assumed that intervention strategies developed on site are highly likely to have a clear strategic focus and to occur at relevant and timely intervention points. The schools in the study were, nonetheless, relatively passive in terms of curriculum development as teachers were more inclined to seek the intervention of experts than to determine their own solutions to problems. This is contrary to Hamilton's study (Chapter 2) in which solutions to problems of implementation were developed within the science departments. However, having a leader is in itself not a panacea to problems in implementation of change.

As the literature shows, the multi-faceted role played by leaders in any organisational setting is a sensitive and difficult one. For instance, some leaders have been found wanting in their ability to identify problems and to engage as active staff-tutors. See, for instance, Constable, Farrow and Norton (1994). On the converse, paradoxically, a leader playing 'expert' could be misconstrued as parading his/her superiority or privileged position over teachers. However, depending on the organisational set-up, leaders are sometimes seen positively and have substantial responsibility and accountability to both staff and schools. An example is drawn from Earley and Fletcher-Campbell's (1989) study on change management in England. They state that:

... not unlike their British counterparts, most North American high schools are organised on a departmental basis and teachers tend to identify with the department rather than with the school overall, and therefore department heads are a 'leverage point for change' and have responsibility for 'making things go right' (p. 132).

Conversely, the said expertise could be seen as divisive in contrast to the democratic ideal of collaborative partnership (cf. Delamont and Atkinson, 1985, p. 34). The foregoing create a background for examining the organisational context of schools in the study.

As explained in Chapter 8, the hierarchies in schools were more bureaucratic than professional *per se*. This explains their detachment from curriculum implementation. Teachers themselves recognised this fact, hence they used them (i.e., middle managers) mainly as channels of communication with experts outside schools. This highlights a dilemma in the criteria for promotion to two seniority posts namely, head of department and senior subject-teachers. The incumbents have not received any training which distinguishes them from their subordinates. This highlights a very important point which undermines both the teachers' and the middle managers' interest and loyalty to their subject areas. The issue considered here is particularly that 'survival' in the teaching profession of individuals is ensured to a very large extent by the wide availability of posts and appointments outside the realms of science teaching. The overall effect of the promotions in science teaching is to lessen the significance of being a science subject teacher; it becomes something transitional, subsidiary or peripheral to administrative responsibilities in schools.

For instance, some science teachers in the study were senior teachers in 'departments' of sports, guidance and counselling, and administration. The posts, available on a large scale, carry similar privileges to those of senior science subject teacher. Senior teachers in the guidance and counselling department further their education in the new field. Also, due to wide prospects for promotion in schools there exists for teachers an inter-role conflict (Datta, 1984, p. 118). Inter-role conflict "arises because the same person attempts at the same time to enact two [or more] roles which do not easily reinforce each other" (ibid.). Examples of the situation drawn from Chapter 8 include a science teacher who did not prepare a lesson for his Form 1 class on Measurement of Mass as he was busy the previous afternoon with school athletic activities. Other science teachers earmarked for promotion to administration posts attended workshops during school hours at the expense of their pupils. Involvement in the extracurricular activities and other non-teaching responsibilities tend to be valued as they stand out in curriculum vitae of individuals compared with science teaching which is taken for granted.

In the absence of purposely established structures to ensure advancement and retention of teachers in science teaching, teachers might remain largely indifferent and apathetic to both

science teaching and to wider issues on curriculum implementation. This is akin to the situation in one of Hamilton's schools in which the curriculum was grafted onto existing science departments. Implementing curriculum under such circumstances is difficult for the situation affects teachers' perceptions of their tasks together with the approaches, commitment and modes of thought they bring to teaching. The meaning and intentions of the curriculum cannot be preserved in such circumstances. And, as was the case in Brown and McIntyre's (1978, p. 22) study, teachers were clearly within departments which showed no systematic concern with what happened inside the classrooms. For schools in this study, the lack of collegiality among science teachers was noted and reported in Chapter 8. Combining that with the generally poor strategies for teaching, it is argued that these are manifestations of the effects of weak organisational structures for supporting the implementation of change within schools. Lack of collegiality in teaching is considered in the next section.

11.1.2 Collegiality amongst science subject teachers

Collegiality among teachers is considered here for three key reasons. Firstly, it emerged in the data as a missing aspect in organisational structures for implementing the curriculum. Secondly, collegiality is taken to be a primary tool essential for the establishment of both the vertical and horizontal channels of communication and learning within a school on change implementation (see Fullan, 1995, pp. 17-18). Thirdly, in line with the view that curriculum change can deskill teachers, collegiality forms a framework for collective action for, as Shulman (1987a) states:

... a community of tacit knowledge has serious limitations if it truly values reflection and deliberation about both ends and means. The essence of community is the capacity to commune, and a community that cannot articulate and exchange ideas on its goals and actions is a severely limited social and intellectual entity (p. 480).

Tobin (1995) expands on the view and states that:

... it is imperative that practitioners reflect on their actions, and thereby ascertain what happens and reasons for what happened. ... What is required here is deliberate reflection on action and interactions among participants to ensure that their own experiences become sources for their learning. ... The quality of reflection for participants at an implementation site becomes a critical issue for staff development (p. 281).

Ben-Peretz (1995) neatly sums the point in stating that "collaboration and sharing of experiences and knowledge are deemed essential for teachers' ability to cope with innovations" (p. 433).

Collegiality, defined here as 'collaborative partnership' in the implementation of curriculum within schools (see Hoyle, 1975, p. 339), has some strengths worth listing. As a strength, it enhances the role and status of teachers in curriculum implementation. As Pollard (1982) states: "conflicts, dilemmas and contradictions in the teaching role are not faced alone. Teacher culture acts as a means of protecting teachers from the difficulties of their roles in many ways" (p. 25). It

may also offer consolidated support to leaders. Furthermore, collegiality constitutes a framework for sustained and durable changes and solutions to problems of implementation particularly where there is a strong team spirit amongst group members.

In fact, Ball and Bowe's (1992) investigation into the impact of the 1988 Education Reform Act on teaching of science, mathematics and English in four case study schools in England and Wales produced evidence that "low capacity, low commitment and no history of innovation results in a high degree of reliance on policy texts, external direction and advice, which in some circumstances verges on panic or leads to high uncertainty and confusion and a sense of threat" (p. 112). According to Ball and Bowe, the concept of capacity "refers to both the experience and the skills of the members of the department in responding to change". Commitment "refers to existence of firmly held and well-entrenched subject of pedagogical paradigms within a department or school". Low capacity and low commitment prevailed in the schools in the study in Botswana particularly because of the predominance of young teachers who were actually inexperienced in handling a curriculum change. But with teachers acting as individuals, that did not help develop a joint position on how best to handle the change, hence low commitment was prevalent. Corporate action or adjustments, including new patterns of co-operation among teachers and the redistribution of resources, which Brown and McIntyre (1978) call "organisational innovation" (p. 20), is by far easier to achieve than "pedagogical innovations" which require teachers to change their behaviour, teaching styles and thus threaten and interfere with their professional autonomy (ibid.).

What is intriguing with the situation in this study is the conspicuous absence of the Curriculum Development Unit (CDU) from active participation in the implementation of the curriculum. The inadequacy and inefficiency of documents in disseminating knowledge about the curriculum has been noted earlier in the previous chapter. On the other hand, the sole participation of the Teacher Training and Development (TTD) unit in curriculum implementation, and with emphasis on mixed ability teaching, falls far too short of Havelocks' model of knowledge transfer. The model is based on the view that "curriculum implementation is essentially a process of knowledge dissemination and utilisation" (Tamir, 1980, p. 71). Evidently inservice workshops did not facilitate exchange of information between teachers and TTD. The absence of CDU seems to suggest existence of "top-down" approach separating policy formulation (the responsibility of CDU) from policy implementation via the support services of TTD (cf. Fitz, Halpin and Power, 1994, p. 54).

Evidently, the distinction between formulation and implementation of policy has not in any way helped the situation which was fraught with problems relating mainly to lack of procedural clarity, support documents, and appropriate professional support. Thus, the feedback cycle which would have taken on board the socio-political factors of teaching, classroom contingencies, and

work context of teachers, did not exist. The mixed ability workshops supported the concerns with mixed ability enrolments and not the needs of the curriculum itself.

In the above context, collegiality based on openness and acceptance of strengths and weaknesses of individual members of the group may enhance the groups' problem solving capability. This would provide a forum for science teachers in which to discuss problems of mutual concern in contrast to departmental board meetings (see Chapter 8) with a wider and open membership of subject teachers from agriculture and mathematics. However, collegiality of teachers in the study should be appropriately seen in the context of the overall centralised administration of education in Botswana. As Constable *et al.* (1994) note, relative autonomy of department and individual teachers tend to deform change intentions. This points to a potential conflict between promoting collegiality on the one hand and maintaining external control over implementation of curriculum on the other.

The current centralised authority through the Ministry does not guarantee the fidelity of implementation, but has firm control over the curriculum and has promoted teachers' dependency on it for advice. Thus, the centralised control has helped to restrain spurious or utterly off-course initiatives in the face of difficulties since teachers would rather wait for directives and expert advice. Also, in view of the widespread dissatisfaction of teachers with the Ministry's involvement in implementation as noted in Chapter 8, collegiality enforced through unrestricted devolution of power to science departments might turn into 'anti-technocratic' or 'anti-bureaucratic' instruments (OECD, 1973, p. 183). Furthermore, as A. Hargreaves (1981) notes, enhanced collegiality might "thrust many teachers into a relatively unfamiliar arena of decision-making, debate and reflection about educational activity" (p. 305) (cf. one of Hamilton's schools where subject-specific teachers shunned the task). Here also lies some potent difficulties:

... the buoyant optimism of teacher participation drummed up by its supporters may, when it meets the seemingly immovable obstacle of institutionalised power, simply plunge teachers into deeper morass of cynicism, despair, and low morale than the one from which ... the movement was explicitly designed to extricate them (*ibid.*).

The citation highlights some of the intricacies involved in balancing demands of institutionalised power and the 'problem-solving adequacies' of science departments which can be brought about through improved collegiality amongst teachers. It would appear the weak collegiality in the implementation of the curriculum is a necessary instrument for enhancing the bureaucratically and centralised control of the curriculum. For instance, where there is enhanced collegiality, a situation likely to arise is that in which "the [external] advisor may come to see himself as the innovator facing up to internal resistance" (Havelock and Huberman, 1977, p. 134) in schools because teachers can increasingly "become skilled visionaries rather than technocratic" (Savage, 1998, p. 55) and question the authority of experts. So, in terms of implementation of curriculum

the low levels of collegiality helps keep schools accessible and open to external influence such that external control of change implementation can be easy. This has disadvantages as this study shows that where external agents fail to deliver, curriculum implementation collapses. This leads to the next section on roles in curriculum implementation of some units of the Ministry.

11.2.0 The Ministry's Role in Curriculum Implementation

The purpose of this section is to examine the impact of centralised authority on the implementation of the curriculum. As Chapter 8 shows, this follows the fact that teachers consistently complained about what they felt was inadequate assistance of the Ministry in the implementation of the curriculum. The two key departments at the Ministry, TTD and CDU, are directly involved in curriculum change and its management. However, CDU played a much more passive role after the syllabus document was despatched to all schools in late 1995. The TTD, charged with teacher inservice, became active in the implementation phase, though to teachers' dissatisfaction. The focus is on the latter department, and on how its operations impacted on the implementation of the curriculum.

As was said in Chapter 1, the centralised education system in Botswana has been in place for more than three decades. It is used primarily as a tool for managing the educational establishment. From its inception, it made it possible to offer education to Botswana under very difficult conditions such as a poor economy, an underdeveloped educational infrastructure and communication networks. The centralised system made possible the availability and management of teachers, comprehensive curriculum packages complete with syllabus documents, teachers' guides, pupils' worksheets, and textbooks. The documents were operationalised by both the syllabus and the intentions of policy-makers. It was thus a fail-safe mechanism, simultaneously educating both the teacher and the pupils while ensuring basic minimum compliance and coverage of the ideal curriculum. The strategy was by then appropriate if viewed against a high turnover of expatriate personnel and a large contingent of unqualified science teachers (see Prophet and Rowell, 1988; Yandila, 1992). The deliberate exploitation by the government of the efficacy and efficiency of the delivery system in facilitating science teaching under the then harsh conditions would therefore not support any suggestion of the teachers being portrayed as 'technicians'.

However, with the improved availability and stable supply by Colleges of Education of qualified teachers (see Prophet and Rowell, 1993), and with the corresponding reduction of unqualified and expatriate teachers, it appears there was a change in strategies of managing the curriculum. The form of curriculum packages became less elaborate from as early as 1992. Pupils' worksheets were withdrawn such that pupils relied for information on teachers and textbooks. That marked the beginning of major changes in teacher and curriculum implementation support system of the Ministry. It could be that TTD and other units in the Ministry felt that teachers were adequately

prepared to handle teaching at CJSS. In fact, Prophet and Rowell (1993) point to the fact that local teachers who implemented the then (i.e., 1986-1995) student-centred curriculum were "relatively highly qualified, having graduated from the rigorous training programmes, which emphasise student-centred approaches in the classroom" (p. 197). The predominance in schools (19 out of 26 teachers) of a similar group of teachers has also been noted in this study. The Ministry of Education, through TTD, has of late also placed its emphasis on identifying and attending to the needs of teachers (McDevitt, 1998). McDevitt explains:

In 1996 the Botswana Inservice and Preservice Project was launched to work with, inter alia, the inservice teams in an effort to enhance their support services. One of the first tasks of the project was to carry out a national needs analysis, and the top priority identified by teachers, school heads and the inservice officers was the need for training in mixed ability teaching. This was also supported by a recommendation in the government white paper. ... It was decided to train inservice teachers using the cascade model in order to give as many teachers as possible hands-on experience of the proposed techniques and hence maximise their impact in the classroom (p. 425).

The citation puts into perspective and corroborates most of the concerns raised in Chapter 8 by teachers about the predominance of workshops on mixed ability teaching. The approach swayed Inservice Officers away from *what change agents must learn viz.:* conceptual-diagnostic training; orientation to theories and methods of change; orientation to ethical and evaluative functions of the change agent; knowledge of sources of help and, operational and relational skills (see Lippitt, Watson and Westley, 1958, cited by Hoyle, 1975, p. 304). These are the core areas for curriculum change as evidence from elsewhere shows. For instance, the areas of specialisation were integral to the SSCEP project in Papua New Guinea. According to Vulliamy (1981a, p. 5) the team which directed the project consisted of a "national co-ordinator, and specialist in curriculum, educational psychology and educational measurement". Between them they helped "the trial schools to devise new integrated curricula, new approaches to teaching and learning, and new modes of assessment, to be tailor-made for the SSCEP programme" (ibid.). Though this was a project (see debates on issue by Vulliamy, 1984; and Crossley, 1984) and was thus distinct from the large-scale and nation-wide non-trial tested curriculum change in Botswana, the example nevertheless shows a strong understanding by the SSCEP team of the requirements of change management.

On the contrary, and because of the focus of TTD, there was thus no forceful and supportive impetus for change from outside the schools. This includes the apparent lack of input in workshops by both the Colleges of Education and the University of Botswana. The linkage of the curriculum with organisations external to schools remained weak. So, it should be no surprise concern existed regarding the emphasis on mixed ability teaching, involvement at workshops of only one In-Service Officer, and the appropriateness of the workshops themselves. McDevitt, himself based in Francistown and working for TTD, gives an insider account lending credence to concerns teachers raised in Chapter 8. He states, with respect to the cascade model of promoting mixed ability teaching amongst science teachers that:

A further drawback of the cascade is that once it has been set in motion it is difficult to view it as anything but a one-way transmission ... There are also very few opportunities to check that the areas the trainers perceive as problematic reflect the real problems in the classroom. Although the Botswana mixed ability cascade was developed in response to an initial needs analysis, clearly that was only a very crude instrument for signalling a major area of weakness; the inevitable synthesising of individual comments can lead to a very bland summary of the situation. It can be quite discouraging to find in the evaluations of the final stage of cascade comments such as these: The workshop needs to focus on more specific issues (such as science practicals...); Too much focus on what is already known; Participants should have been screened to see who really needed this workshop (p. 427).

Evidently TTD occupies an ambiguous position with respect to the implementation of the curriculum. First, with its attention focused on mixed ability teaching, there was a weak provision or lack of proper provision by the Ministry for overseeing the implementation of the curriculum both at school and national level. Teachers had to do without the professional assistance they needed in operationalising the curriculum. This also raised concern over the 'ownership' or 'identity' of the curriculum as the Ministry appeared indifferent both to the curriculum and to the teachers. Second, the six regional inservice teams, serving all the 230 CJSS nation-wide (McDevitt, 1998, p. 425), each having one science subject specialist, and assuming equal distribution of schools between trainers, is very inadequate to cater for science teachers both at regional and national levels.

In terms of the implementation of the curriculum, the narrow scope and mandate of the TTD meant that it was inadequately equipped and prepared to deal with the contingencies and with other specific issues on the implementation of the curriculum. The evidence supporting this assertion is in Chapter 8 where the Inservice Officer, being in TTD, reportedly disassociated herself from the specific issues teachers raised about the curriculum. Instead, the officer referred teachers to the Curriculum Development Unit (CDU) under whose auspices the curriculum materials were developed. This clearly meant that there was no department which had a mandate to solve problems teachers encountered in curriculum change.

Also, while the education 'revolved' around a centralised authority, the parody of the situation is that the wider bureaucratic structures through which authority was supposed to originate failed to exert decisive influence on either the teachers or on the implementation the curriculum. Therefore the authority remained something of a weak and ineffective 'force at a distance' largely alienated from the curriculum change. In that way, TTD had failed to align itself or to streamline its activities with the requirements of the curriculum change. Thus, it effectively failed to participate in the implementation process and, hence, it failed teachers who, as evidence in Chapter 8 shows, had indicated a strong desire to know more about the curriculum as well as to have their specific problems attended to. The next section explores how and what roles teachers have taken up in such a situation.

11.3.0 Teachers' Role in Change Implementation

The justification for developing this section is founded on two points. One is that teachers are the primary users of the curriculum. Second, despite that position, they are excluded from policy decision-making and restricted only to teaching. The operations of TTD as explained above illustrate the point. Following from the foregoing reasons, teachers are appropriately seen here as resources or tools for change because their activities are restricted to implementing decisions whose formulation they were not party to. Thus, using the concept of teacher as a resource or tool as a framework for interpretation, the overall aim of this section is to explore how teachers acted out their roles and how that impacted on the implementation of the curriculum.

The discussion is in three inter-related parts. First, it explored how teachers were managed by the Ministry. The second section critically examines some aspects of teacher practice as a way of understanding their positions as tools in the reform. The third section explores the impact on change implementation of the relationship that teachers had with the Ministry. Evidence from the data is used as a basis for the discussions such that a working definition of role adopted here is that taken to mean inferences drawn from regularities in 'reality' as contained in the research data.

11.3.1 Teachers as resources

As Davies (1988) has said, teachers in Botswana are part of the government's resources for education. Harber and Dadey (1993) and Mautle and Weeks (1994) provide some insight into the overall operative context of teachers in Botswana. The management of the resource is effected by the Ministry through the Teaching Service Management (TSM) responsible for, among others, appointments, promotions and transfers of all teachers in state-run institutions. There is also the Teacher Training and Development Unit (TTD) which is the inservice unit in the Ministry. Both departments are largely autonomous and independent of each other operationally, though both are concerned in different ways with the 'management' of the same pool of teachers. What is briefly explored, then, is how they collectively impacted on the implementation of the curriculum.

The relationships that teachers have with the two departments are by and large bureaucratic, detached and contractual. TSM have school heads as their immediate contacts and advisers on individual teachers' appraisals. Decisions to promote or otherwise are taken by TSM independent of the school heads. Teachers are thus 'invisible', or rather, are objects to be manipulated within the whole. TTD, too, occupies an ambiguous role in managing teachers. It seems that the TTD-arranged workshops constituted the main mode and instrument of maintaining contact with teachers. As evidenced in Chapter 8, attendance by any one teacher in the workshops is irregular and on a weak rotational basis. The effect of the arrangements on the management of teachers is that In-service Officers may not have in-depth knowledge of the strengths and weaknesses of those teachers under their jurisdiction.

In terms of implementing change, lack of such knowledge means ineffective identification of teachers who can be effective props in initiating, promoting and co-ordinating change in a region. As shown in Chapter 8, some teachers who had been appointed resource persons for some workshops had either been looked down upon by their colleagues or reneged on the agreement, thus throwing workshops into disarray. Also, since the TTD and TSM have different and independent mandates, transfers of teachers by TSM would not consider their involvement through TTD in regional activities on implementation of change. During the fieldwork, two science teachers were transferred on promotion to posts in schools elsewhere in the country. They were replaced with new graduates from Colleges of Education. This impacted on the overall 'ecology' of science teaching in the schools and region. The transferees themselves would perhaps have been better suited to areas within which their merit was recognised. On the other hand, their departure created voids in respective schools which may not easily be filled by novice teachers who had first to contend with the challenges of shaping their own practice and profession (cf. Gonzalez and Carter, 1996; Denscombe, 1980).

What remains unknown considering the detached and contractual links TTD and TSM have with teachers is first, the capabilities and skills of teachers to implement change; second, the distribution of such skill across regional schools. Thus, the existing set-up for the management of teachers is not effectively organised to identify, develop, organise and harness the skills and knowledge, latent or otherwise, that teachers might have for purposes of implementing the curriculum (cf. Hamilton's schools). This had the potential to impact negatively on teachers' attitudes to curriculum, particularly if they saw it as something detached from them and for the experts to unravel. However, as Chapter 8 evidenced, teachers did not reject the curriculum but were positive that they could work well with proper workshops, expert advice and curriculum materials. The problem as articulated above is that TSM and TTD were at best largely service departments of the Ministry and interacted with teachers from that position. It is in this set-up that teachers as tools in change implementation operated. The next section focuses on how they performed their teaching roles.

11.3.2 Taking up of roles by teachers

In Chapter 8, evidence of teachers' uncertainties, confusion, quest for knowledge and guidance on implementation of the curriculum were presented. According to Fullan (1982), Havelock and Huberman (1977), the confusions are normal because teachers respond variously to change. Furthermore, Dalin (1973) and OECD (1979) lists 3 types of conflicts that might affect implementation of the curriculum. They are: the psychological, the value and practical conflicts. With such a wide-range of challenges impinging on teachers, the curriculum reformers most feared scenario is that referred to as 'change without change syndrome' (Lewin, 1991) or, change

in appearance but not in substance (Huberman, 1979) of the curriculum. Fullan (1982) appropriately made a surmise about the situation: 'implementation does not imply change'.

As Gross, Giacquinta and Bernstein (1971) state, lack of understanding of new roles required by the new curriculum can necessarily cause the failure of its implementation. Playing a role is much more than taking a role as the former implies that the incumbent is proactive as opposed to being passive. Change necessitates learning and re-learning what and how to teach, and of perfecting ones' practice (Fullan, 1982); it thus implies a measurable degree of intra-role conflict (Datta, 1984) arising from a "single role containing elements that are not easily harmonised" (p. 118). In essence, the latter point defines the basic framework for examination of teachers' roles in change implementation. The reason is that the study was conducted after 18 months after the three-year long curriculum was introduced into schools.

As Brown and McIntyre (1993) assert:

... the major constraint on the acceptance of innovations by teachers is their perceived impracticality and that to have a chance of being perceived as practical, plans for innovation would have to take account of what is already being done ... For the innovation to be 'practical', however, it would have to be so clearly superior to the established practices, and so certainly achievable and safe, as to justify the abandonment of the extensive craft knowledge about when to use what tactics, that each teacher had built up over the years (pp. 116-117)

For Olson (1992), playing a new role is facilitated by the tension between the old and the new:

... the tension between the old and the new is the engine which drives critical reflection - it is the source of energy for interpretation. The new says something about the old - often the new is seen as a criticism of the old. The new, wherever it comes from, causes reflection of the old, it introduces new language, upsets old assumptions, threatens loss and promises plenty (p. 80).

The argument above seems to be along the rational-empirical change-strategy which assumes that, according to Hoyle (1975), it "is the concern of all parties to resolve a particular problem and that men respond rationally to the demonstrated superiority of an innovation over previous practice" (p. 295). Taking the two citations as points of departure in the discussion of the role teachers played in the curriculum change, the evidence in Chapter 8 has shown that the difference between the old and the new had been identified by teachers. However, the deeper meaning and nature of the change remained illusive. But, as evidence in Chapters 5 to 7 show, lack of proper documents and guidance did not satisfy the teachers' need to know more about the curriculum. Instead, the curriculum remained largely inaccessible and complex, which two factors Fullan (1982) and Bolam (1975) cite as potent inhibitors of change. There are also some two more profound issues.

Despite the use of instructional objectives as a framework for defining curriculum, the inaccessibility of the curriculum to teachers was rather paradoxical on the grounds that the curriculum is founded on the same philosophy as its predecessor, implemented in CJSS for a decade (1986-1995). But as Woolnough *et al.* (1985) would argue, one of the precipitating conditions for implementation is some form of readiness for change derived from teachers' agitation with existing curriculum. They state that "there must be a recognised need, a dissatisfaction with the existing science curriculum and a sympathy with the spirit of the new innovation" (p. 211). But then it is not clear, apart from factors such as lack of *conceptual* and *procedural* clarity (cf. Brown and McIntyre, 1978) in the syllabus, how the externally imposed change represented a significant paradigm shift for teachers in terms of the philosophical curriculum base and of the new relationships teachers had to develop with their pupils, curriculum materials and teaching environment in general. As Volmink (1998) notes, "any paradigm shift must come from a shared perspective. Indeed, it may be counterproductive to suggest radical change without taking into account the extent that the vision is shared and, equally important, the systemic implications of change" (p. 69).

However, it was noted that teachers in the study were more prone to being reactive than proactive, so failed to impose their own interpretation on change. With the problem evident 18 months after the change was introduced, it could be argued that there had not been a tradition of critical, philosophical and practical awareness and thinking about the aims and objectives of the curriculum and of how to use them as a basis for instruction. The key consequences of this are two-fold: teachers lacked clarity about key concepts of the curriculum (as reported elsewhere in this chapter) which impacted negatively on their morale and motivational levels as well as on their understanding of their new roles. The second key problem, subsidiary to the first, is easily identifiable in the nature of explanations given by teachers. Teachers placed emphasis on technical explanations for their practice. Thus change is seen as being akin to a rational undertaking or an industrial innovation. See, for instance, Huberman (1977), Jansen (1989) and Wise (1977) for similar arguments. The explanations were in terms of typical parameters for assessing the 'technical efficiency' (Urwick and Janaidu, 1991) of schools to handle curriculum change. Some parameters are: inadequate levels of support, the curriculum, heavy workloads, material shortages, and class sizes. Concern with technical matters meant that the role to be played by the teachers remained relatively unexplored by teachers themselves. Thus, they were not reflective of their practice. As McKinney and Westbury (1975) aptly observed: "at the point at which innovation must be adopted, new problems arise, centering not so much on the virtues of the innovation as on the feasibility of adoption - more often than not a question of resource availability" (p. 47).

Several speculative explanations are offered to explain the situation. One could be that teachers were operating within a tradition in which technical explanations have been and were still valid

and predominant frameworks at school and at national levels for understanding teacher practice. In fact, problems of teacher shortages and heavy workloads which became apparent in Phase 2 of the fieldwork (Chapter 7) tend to support the mindset of teachers. The immediacy of the problems to teachers cannot be denied. Furthermore, teachers had not rejected the curriculum. Neither had they seen it as impractical. Thus, at this stage there is no basis for applying Doyle and Ponder's (1977) notion of "practicality ethic", which essentially concerns the labelling as impractical or not of the curriculum by teachers. What we see is teachers' concern with their professional self and with the various challenges that they are faced with in implementing the curriculum. The authority of the curriculum was further eroded by the fact that the design, development and dissemination of inservice support for the curriculum did not consider the wider culture of the host environment. The second explanation relates to the operations of TTD as explained early on. With the TTD possibly seeing teachers as *intellectuals* and adequately trained for the job (see also Prophet and Rowell, 1993), certain tasks such as interpreting and operationalising the syllabus are taken to be within the professional competence of teachers. Hence the finer details of making the curriculum work might be overlooked.

More explicitly and to summarise the arguments above, the curriculum itself seemed to be not well integrated into the roles and status structures in which teachers operate in the schools. If it had been, teachers might have implemented it without feeling deskilled. As Brown and McIntyre (1993) stated:

... those proposing innovations have not in general been able to engage in rational consideration of the costs and benefits implied by innovations because the cost in terms of lost potential craft knowledge and in terms of new craft knowledge to be acquired have not been explicit (p. 117).

Furthermore, the curriculum was not a self-contained instructional system or blue-print complete with a set of stated pedagogical assumptions, details of techniques and equipment (cf. Hamilton, 1975, p. 182). This points to two inter-related factors.

One is that curriculum development must change classroom practice if it is to be judged as successful and as authoritative. Equally, the curriculum must be self-justifying to teachers and must enhance their understanding of the rationale of the curricula change. Both aspects were missing from the curriculum. What appeared to be the naturally low adaptability of the curriculum, seen from the user's standpoint, is its major weakness. In that way, the dependence on the external authority (i.e., Inservice Officer) for guidance displayed by teachers highlighted problems with the uptake of the curriculum. Perhaps it suggested that teachers did not see their role as carrying any power or authority that would support their activity as tools for change in schools (cf. Earley and Fletcher-Campbell, 1989; Fraser *et al.*, 1992). What was not explored in the study, though, and was not apparent from field data, are the ideological positions of teachers

which as Lynch (1997) and Tobin and Fraser (1989) suggest are powerful factors in the implementation of the curriculum.

Following from the preceding discussions, several points can be posited regarding the roles of teachers in change implementation. In view of the fact that 19 of the 26 teachers in the study were nationals specifically trained to work in CJSS, it can be argued that their impact in implementation was not a substantial one and that their training had not prepared them to play an influential change role within the curriculum macro-system (cf. Lillis, 1983, p. 237). Furthermore, as Woodhouse and Eukolia (1986) state in a Nigerian case study, "the implementation of policy has done little to encourage teaching of science in an enlightened and discursive manner" (p. 115). The latter point has been explored earlier and indirectly by examining the role of TTD in curriculum change. The point forms a justification for the next section in which teachers' roles are examined broadly in terms of the relationship between teachers and the Ministry of Education. Particular emphasis is placed on how the relationship impacted on teachers' roles in the implementation of change.

11.3.3 Teachers' role and relationship with the Ministry

Vulliamy, Kimonen, Nevalainen and Webb (1997) argue that "teachers' self-identities are powerful mediators in terms of their interpretations of and responses to imposed changes" (p. 97). They also assert that in relation to the implementation of the National Curriculum in England, "as a result of experiencing imposed changes in practice, some teachers are questioning previously held assumptions and changing their beliefs" (pp. 110-111). This point is similar to Olson's (1992) position that the tension between the old and new curriculum facilitate interpretation of change. Further, Vulliamy *et al.* (1997), citing Nias, reiterate the importance of preservation or protection by teachers of their occupational role and identity: "the protection of a core of self-defining values becomes a high priority in teachers' professional lives" (p. 111). Vulliamy *et al.*'s findings are used here as a starting point on the discussion of teachers' occupational- and self-identities evident in the data. This further explains how they responded to change and to their perception of their roles within it. It is argued here that their occupational roles and identities were inseparable from the centralised authority system of the Ministry of Education.

In Chapters 7 and 8, teachers' accounts showed that their practice was justified mostly in terms of teaching constraints and in terms of the inadequate guidance provided by the Ministry. Here lie some important implications for teachers' self-identity and occupational roles. Their occupational roles were closely tied to the authority system mediated through directives and syllabus document on the one hand, and bureaucratic structures on the other. The value system that teachers maintained during implementation of change mainly comprised allegiance and loyalty to the Ministry: teachers' primary relation in education or their profession is with the Ministry of Education and it is through the relationship that teachers relate with other parts of the system viz.;

other teachers, the school administration, pupils, curriculum and other educational resources. If the primary relationship with the Ministry becomes dysfunctional, then collapse in teachers' work organisation or ethic, morale and motivation follows. It was clear from their views that their positions within the education system had been undermined by the curriculum change.

The positions invariably define their professional and occupational roles within the centralised system and not in schools or classroom *per se*. This position seems to contradict Broadfoot and Osborn's (1995) observation that "external directives in themselves are not sufficiently powerful to change the educational values which provide the core rationale for teachers' actions" (p. 1). The point is that teachers had developed a culture which was highly deferential to authority and to centre-based decisions. This created what could be described as an institutionalised context of dependency. The position is explored through a brief discussion on how teachers' value system was manifest in their work. An illustration of the way in which the value system impacted on teaching is also made.

As explained above, the teachers' role in the implementation process became ill-defined when the Ministry failed to give teachers proper guidance consistent with and supportive of teachers' perceptions of their occupational role. Had the role comprising teachers "sense of worth ... sense of positive affiliation with others ... [and] sense of control or influence over what is happening or will happen" to them (Fantini and Weinstein, 1977, pp. 19-20) been supported, it is argued that a different image of teaching would have emerged. As Blauner (1964) explained,

when an individual lacks control over the work process and a sense of purposeful connection to the work enterprise, he may experience a kind of depersonalised detachment rather than and immediate involvement in the job task (cited by Webb and Ashton, 1987, p. 31).

In this sense, Sieber's 'co-operator type' of teacher - a person who wants to volunteer and only needs to be shown an appropriate direction in order for her/his commitment be secured (see Olson, 1992, p. 3), is espoused though it is an oversimplification of the relationship between the teacher, the curriculum and the Ministry.

To further illustrate the impact of the value system on change implementation, Kallos and Lundgren's (1977) position is adopted. In brief, they state that teaching experiences in classrooms may be "regarded as regulated, directed and constrained via the mediating decisions taken at various levels within the state" (p. 13). This is consistent with viewing teachers as tools for change implementation. The essence of their debate and that of seeing teachers as tools is that there is an asymmetrical power distribution in the education system. It is the imbalance in power distribution on which teachers' value system is based and through which they see their roles in the change process. As Kallos and Lundgren note, 'the important constraining and directive role of the fiscal decisions is often overlooked, although such decisions have a measurable impact on

subsequent decisions and on the actual teaching' (p. 13). Instances of consequences of the asymmetrical distribution of power in change implementation have already been given in this chapter. For instance, teachers' lack of personal positions regarding the curriculum have been noted in this work in terms of the absence of a tradition encouraging critical and philosophical awareness of not only the curriculum, but their role in implementing it. The operations of TTD which neglected teachers' real problems with change implementation, hence showing little accountability to teachers, is another example. Further illustration of the asymmetrical power distribution is made here through exploring how teachers perceived their own and the Ministry's role in change implementation.

When the curriculum was introduced into schools, there existed asymmetrical power and knowledge relationships between the Ministry (the innovators) and teachers who had practical experiences of implementing the previous curriculum. The Ministry was *naturally* burdened with the responsibility of initiating and establishing an educative process with teachers. On the other hand, teachers had to utilise their teaching experiences and conception of curriculum as elements of a framework for understanding the meaning and implications of the new curriculum to teaching and other occupational roles. From the evidence available on the conduct of workshops and teacher support materials, the educative process had not been possible to achieve as the Ministry had failed to be available for the process. A lasting change in teachers' practice could have been facilitated by a reciprocative relationship between teachers and the Ministry. The Ministry was seen predominantly as a leader and was expected to play a predominant role in the implementation process. The failure by the Ministry to meet the expectation created both real and psychological barriers (see OECD, 1979; Dalin, 1973) to change. The ownership of the change by the Ministry is generally seen as crucial to the sustainability of the curriculum. As noted earlier, the problem seemed to lie in the separation in the Ministry of policy formulation and implementation. But, the evidence further shows that teachers had a clear perception and understanding of where they stood with respect to the curriculum on one hand, and the Ministry on the other.

While the dysfunctional relationship and its influence over implementation of curriculum is prevalent, it could be argued that by implication teachers did not assign high priority to questions related to the teacher aspect of the curriculum materials. The new curriculum thus emerged to threaten the existing relationship especially of introducing new changes and challenges which teachers felt inadequate to contend with. The potential of the teachers to act was not manifested so they became frustrated as so little of their total skill and experience repertoire was involved in their work (Whitaker, 1995, p. 121). In this situation teachers worked "for a system they do not control, which operates as an independent power to which individuals must submit" (Burns and Stalker, 1966, p. 11). Evidently, the Ministry and teachers were locked in rigid and traditional roles and responsibilities which lacked the capacity to respond quickly to changed situations and

new demands (cf. Whitaker, 1995, p. 88). The relationship teachers had with the Ministry was more than just a means to the end but enduring and deep. Nonetheless, the relationship served to undermine the curriculum which did not carry much authority by itself, and was not effectively and consciously used as an instrument of policy by teachers. It appeared that the responsibility for seeing to its interpretation and proper use lay elsewhere than with teachers themselves.

A similar situation in which the relationship between teachers and the Ministry of Education undermined the curriculum and teachers themselves was noted in South Africa by Chisholm (1999). With the introduction in 1997 of the curriculum 2005 into schools in the "new" non-racial South Africa, Chisholm reports that there was a vacuum created in the support structures by organisational changes in the Ministry. This did not help teachers' re-conceptualisation of their roles and in the fulfilment of their expectations. Chisholm continues: "in the predominantly African schools, teachers were uninspired by curricula which continued to be marked by the past and were waiting for new directions in the field of curricula. By 1998, there were no new textbooks or resources in schools" (p. 122). With the lack of assistance, "teachers were experimenting with new approaches ... Teachers were grappling with issues of multi-culturalism and anti-racism, with the values of society founded on non-racialism and how to embed these in pedagogical practice" (ibid.). Though the situation is radically different from that in Botswana, teachers in both countries were left to their own devices in terms of the implementation of non-research-based politically inspired curricula changes. It is argued that such a situation leaves very little prospect of successful and meaningful implementation of change.

11.4.0 Theoretical Perspectives in Change Management

The arguments in this chapter can be articulated within the centre to periphery thesis of management of change. Donald Schon is associated with the thesis. According to MacDonald and Walker (1976), "the model rests on three assumptions: 1) the innovation exists, fully realised in its essentials, prior to its diffusion; 2) Diffusion is the movement of an innovation from a centre out to its ultimate users; and 3) Directed diffusion is a centrally managed process of dissemination, training, and the provision of resources and incentives" (p. 13). Nonetheless, while the development and subsequent diffusion of the curriculum in Botswana has some attributes listed above, the findings of the study suggest that the pattern can best be characterised as a centralised system. As Owen (1973) would say, the system more or less "ensures the type of uniformity which would ensure comparability of standard, of method, and of the content of the curriculum" (p. 19).

The point here is that the basic assumptions of the centre to periphery model have not been fully satisfied in the schools in the study. While the Ministry (the centre) developed the curriculum through a task force, it (centre) is manned by administrators who are part of the oligarchic structure of controlling the education system. I believe this is contrary to the initial conception of

the model because the centre is managed by educationalists who develop finished products for schools and then monitor their use through active feedback networks. As has been shown by the research findings, the syllabus document released to schools did not form a complete curriculum package. Furthermore, it was not authoritative on subject matter and pedagogic issues of the curriculum. This resulted in teachers seeking more guidance and direction from the centre which, as has been shown, had its priorities on mixed ability teaching and thus failed to give advice as required by teachers. Relationships between teachers, advisors and the Ministry were not reciprocal such that transmission of information was largely one-way. Consequently, as Kelly (1982) puts the point neatly, there was a very wide gap "between the ideals and conceptions in the minds of the curriculum planners and the realities of outcomes of these in the classrooms" (pp. 174-175).

Overall, the handling of change displayed several attributes which defied the assumptions of the centre to periphery model. Chief amongst them are: failure to transfer authority to implement from the centre to the periphery; poor feedback relationships between the centre and the periphery; and, insensitivity of the centre to the socio-political constraints and other conditions (enabling or otherwise) existing at the periphery. Paradoxically, however, teachers clearly understood their positions in the system and looked to the centre to play a leading and dominant role in the curriculum implementation. This has not materialised. This is least surprising because, as argued, administrators and not educationalists run the system. This suggests caution in understanding change in the context of models developed in metropolitan nations.

On the other hand, and to substantiate the latter point, the paradox of this study is that the caveats noted in curriculum implementation disqualifies full adoption of the power-coercive thesis of curriculum change as framework for interpretation. The position is not discussed here: the definition of power-coercive strategies as given by OECD (1973) itself suffices to show the misfit between the definition and the research findings. OECD perceives power-coercive models thus:

The imposition of power alters the conditions within which other people act by limiting the alternatives or shaping the consequences of their acts ... Information or new knowledge is in itself potential power. The flow of information goes from men who know to men who don't know ... In general, however, the political administrative strategies emphasise political, legal, administrative and economic power as the main source of overall power ... Laws have been passed against certain activities or ensuring other, social interaction is controlled by school regulations, economic power is used towards certain end, for example, as support to use part of a curriculum and not the other (pp. 48-49).

The conception and development of policies and concept of basic Education in Botswana fit the above picture. Curriculum change was a political process marked by massive expenditure and political commitment to it although the knowledge, authority and power have not yet reached the

periphery such that what happens in class is largely and directly uncontrolled by external influences.

In summary, the examination of teachers' roles as tools for curriculum change have been variously explored in this section. One main conclusion that can be drawn from the presentation is that the centralised education system, comprising the TTD, TSM and CDU, has all the necessary departments which, if properly co-ordinated and empowered, can effectively oversee the implementation of change. Similar arguments from experiences elsewhere are made by Morris (1986), Garrett (1990) and Prawda (1993). But as has been shown above, the departments maintained weak relations with teachers who, consequently, lost out which resulted in poor implementation of change. Therefore, the situation in schools in the study does not inform us of the usefulness or otherwise of the power-coercive models of change, the centre-periphery approach or, simply "the managerial hierarchical and technocratic framework of change" (see Pedretti and Hodson, 1995, p. 467). Based on classroom observations and in terms of the origins of curriculum change it could be posited that the problems teachers faced in the implementation of the curriculum simply confirms to some degree that the change was not inspired by research evidence from classrooms but by other interests originating elsewhere. Thus, the new curriculum did not enhance or build on the existing practice of teachers and other factors in schools.

11.5.0 Summary

In this chapter, the interpretation of findings considered four interrelated areas on implementation of change. They are: a) the organisational environment in schools, b) collegiality amongst science teachers, c) roles of the Ministry in curriculum implementation, and d) teachers' roles and positions in curriculum implementation. The main emphasis in the discussions in each section was to place the research findings in the wider context of the literature on educational change.

The main factor that crippled curriculum implementation is the apparent failure by the Ministry of Education to participate effectively in policy implementation. Thus, structures in the Ministry failed to avail the much needed authority and support which policy developers and teachers had banked on for guidance and problem-solving in the use of materials. Consequently, the role that the Ministry was to play in change implementation emerged to be an issue of great significance and importance to teachers. All these factors show that teachers had an insufficient basis for action such that goals of the curriculum could not be realised: the uptake of the curriculum by teachers depended greatly on how directive and educative the Ministry was about the curriculum. Furthermore, the traditional conceptions of the roles of the Ministry and teachers held by both camps militated against the implementation of the change itself.

In terms of the power-coercive strategy as a framework for change, it is argued that it was adequate to bring about syllabus changes but was clearly not organised and thus less suited to the

purposes of assisting users to implement the changes (cf. Morris, 1986). As Sinclair and Lillis (1980, p. 165) observed, "the use of government's legal power or of the mere dissemination of persuasive arguments" cannot bring about desired change. In this study, the Ministry of Education must accept responsibility for any unintended consequences of curriculum change. But quite clearly, the paradigm guiding the reform has been lost both in curriculum materials and teacher practice.

The interpretation of research findings in Chapters 10 and 11 was eclectic and the debates were given some perspective by seeing them from several existing theoretical positions in the literature. The positions are: technical procedural/rationality thesis, constructivist perspective, egalitarianist and the centre to periphery thesis. All four served as useful benchmarks and provided points for reflection which were useful for enhanced understanding of curriculum implementation. The positions, though conceived largely in the metropolitan north where curriculum development and implementation is a highly developed professional undertaking, created a lot of awareness which helped identify those forces and power relations that prevented participants in the study from deriving full benefit of the curriculum change. This also helped explain why the change itself was failing. Overall, the centralised system itself was problematic. First the centre itself was weak and ineffectual; secondly, the periphery looked at the centre for professional guidance, inspiration and motivation. This was not forthcoming, plunging the implementation process into a crisis.

CHAPTER 12

CONCLUSIONS

This chapter highlights the lessons learned from the study. It investigated the implementation of an integrated science curriculum in eight schools in Botswana. The lessons learned from the study include three key areas. One is methodology; the other comprises the research findings and the third area concerns conclusions of the study. Also, issues worthy of research which arose during the study but were left unexplored are also presented.

12.1.0 Methodology

This section focuses on three issues: the strengths and weaknesses of methodology, and questions identified and left unexplored in the study. Appendix 11 contains a fuller review of methodology, with particular insight into working with participants in "stressed" and unsupportive situations.

12.1.1 Strengths of methodology

The strengths of the methodology are implied in the data that has been collected in the field and in the insights that it generated. Strength can also be seen in terms of advantages introduced into the study by the methodology.

The advantages of adopting a qualitative and observational research strategy became apparent as classroom observations and interview data related to the everyday classroom experience. The advantages are manifest, for instance, through the fact that the research findings reveal the uncertainties, confusions and dilemmas of teachers as they learn to use the curriculum. As Brown and McIntyre (1993) (see also Olson and Reid, 1982) state "an evaluator who base judgements on observation alone, without teachers' explanations of what they are doing, will do so on an inadequate understanding, or even a misunderstanding, of what is going on in the classroom" (p. 105). This has been made possible by the flexibility in research of the qualitative case study approach.

I believe the other point which illustrates the strength of the methodology is the fact that it established conclusively that teachers perceived the Ministry of Education as failing them in terms of change implementation. The relationship that teachers had with the Ministry and the role the Ministry was expected to play were very significant factors for teachers in their implementation of change. The research strategy has thus captured some important and salient perspectives of teachers' on curriculum implementation. The style of reporting the findings and the framework for interpretation help to further enhance the contribution that qualitative studies make to the understanding of curriculum implementation.

12.1.2 Weaknesses of methodology

However, the methodology had weaknesses which are apparent in the research data. These are considered briefly as part of the possible improvements to the study. Only those key issues impinging directly on outcomes and whose review might shape future studies are highlighted. Two issues are discussed: the focus of the study, and data collection. With the benefit of hindsight, both relate to developing improvements for data collection.

One weakness inherent in the interview strategies is that they did not strictly encourage teachers to reflect on classroom events. Precision of focus and depth of data (Lofland and Lofland, 1984, p. 151) were striven for in data collection, but seem to have been compromised by the exploratory nature of the study. Interviewing alone was not a very *tight* process, as much depended on how teachers responded to interview questions. The relatively loose focus did not in itself distinguish between teachers' topical areas of general interest, issues, concerns, but focused on all of them such that the focus was generally too broad. Thus, it appears teachers focused mainly on the problems of implementation which were perhaps the basic and most readily accessible stage in the complex matter of curriculum implementation.

This suggests the need for change in data collection technique. For instance, adapting Brown and McIntyre's (1993, p. 23) approach in their study on decision-making by teachers, they first sought to identify through interviews those elements of teacher-practice which teachers and pupils identified as constituting 'good practice'. The second step was then concerned with selecting those particular aspects on which research would focus (p. 24). So in my case interviewing based on classroom observations only meant that aspects of implementation were identified within the researchers' own framework and were discussed within the teachers' framework. However, this does not discredit the study and its findings as the study was based on sound methodological principles and practices.

The time factor was also a constraint in this study: more time than was available was crucial for deeper understanding the process of implementation. A suggested improvement to the study acknowledges the literary insight that change implementation is a process which requires long-term study. The findings of this qualitative study in general are temporal as they relate to specific periods and episodes in the named setting. The literature on curriculum change, for instance Fullan (1982), Earley and Fletcher-Campbell (1989), Havelock and Huberman (1977), subscribe to the view that change is a process which occurs in stages. Adoption is the first stage, then implementation, and lastly, incorporation or institutionalisation. It is on this basis that the relatively long gestation period of curricula change has been acknowledged and must be taken into account in future studies. Also, if as it is argued in this study, teachers' primary relationship was with the Ministry, then attention can be directed to discerning how the link is maintained over time, to the form(s) it takes with changing contexts, and how the relationship impacts the

teachers' confidence and competence in implementing change. This can reveal some data on which future introduction of changes could be based.

12.2.0 Unexplored Questions

A number of unanswered questions worthy of research arose during the course of this study. While transactions in classrooms have been noted, the outcomes of instruction were left out. Shaw (1978) suggests that a study of the processes of teaching as well as their outcomes represent greater depth and a more elaborate form of case study. In this instance, the outcomes concern whether pupils found learning science meaningful given their teachers' practices. The research findings showed that teachers had problems with the curriculum, but it was not established whether they were adequately competent to implement the curriculum. Also, as has been noted, none of the teachers complained about their pre-service training as a factor relevant to their handling of the curriculum.

The selected areas partly reflect the weaknesses of the methodology. For, only information supplied by teachers in interviews was sought. This was necessary to minimise personal bias in the study. The areas also evidence my personal commitment to the importance of working extensively in areas (i.e., curriculum implementation) and generating extensive baseline data as a reasonable strategy upon which to base large scale studies.

Having considered the methodological issues, the next section focuses on the findings of the study.

12.3.0 Comparative Review of Findings of the Study

First, an attempt is made to reconcile study findings with those of Hamilton and Prophet and Rowell discussed in Chapter 2. As Merriam (1988) notes, "the value of any single study is derived as much from how it fits with and expands on previous work as from the study's intrinsic properties" (p. 61). The two studies are used as a reference point for developing and highlighting features of the current picture of "reality" in science classrooms. In developing this section, attention is directed first to the characteristics of the research environments of this study as compared with that of Prophet and Rowell. The characteristics form a context for appreciating the findings in respective studies. Hamilton's work shall be referred to where appropriate. Commonalties and differences between the three studies will also be highlighted.

Prophet and Rowell's study was conducted on the first ever science curriculum to be developed locally in Botswana. This study was conducted almost a decade after Prophet and Rowell's and focused on the second generation of locally developed science curriculum. It is based on the same educational philosophy and goals as its predecessor. With the school system having expanded dramatically since the late 1980s, universal access to basic education had nearly been achieved.

Performance in PSLE was and is no longer a criteria for transferring to CJSS, save for situations in which not all pupils in a particular locality can be absorbed by CJSS. The very high transfer rates were a crucial change in education which meant that teachers had to re-conceptualise their roles and functions both in the CJSS system and in basic education. The cohort groups Prophet and Rowell observed were select groups of more capable pupils than those in this study.

Despite differences in the research environments, classroom routines were remarkably similar. Nonetheless, the influence on teaching of printed materials was different. In Hamilton's and Prophet and Rowell's study, practical classroom activities centred around worksheets supplied with the curriculum. In my study, worksheets were not available and there were few practical activities. However, the influence of textbooks on teaching was noted. Pupils were frequently given reading assignments in preparation for teaching, whereupon regurgitation of the textbook material was the norm. This was the teachers' idea of involving pupils in their science learning. But, as has been argued, by neglecting pupils' out-of-school experiences, teaching was predominantly science-centred and teacher-directed. The lack of student-centred learning, also noted in Prophet and Rowel's study, is due to a number of factors including lack of teacher guidance on curriculum implementation. The curriculum package in Prophet and Rowell's study operationalised the curriculum and teachers religiously followed the text material in the worksheets. It appears the concept of student-centred teaching appeared elusive to teachers in both studies.

The study noted that the curriculum neither supported nor ensured cumulative development manipulative skills in learners. Prophet and Rowell's study did not report on the use of out-of-school experiences in class and on how classroom transactions related to the philosophy of relevant education in Botswana. My study has extended their work and has extensively covered these two areas. I believe this to be a contribution to both general and specific knowledge on curriculum implementation. Taken together, my findings and Prophet and Rowell's lead to an intriguing situation in which it is unclear whether it is the teacher, the curriculum materials or both failing to preserve the meaning and central philosophy of the curriculum.

Although Hamilton's study was conducted in a different context, its research findings coincide with those in this study. The problems of fitting a new curriculum to existing practices and organisational structures at Hamilton's Simpson School have been noted in this study, albeit in a different form. Also, Hamilton's study took place in a context in which while the education system was centralised, implementation of the curriculum was in the hands of the science department which had to organise and co-ordinate the activity at school level. The high number of teachers facilitated this. This is contrary to the situation in my study and in Prophet and Rowell's in which the general responsibility for implementation fell on individual teachers, typically two or three per school. The arrangement left science departments and school management teams

unencumbered by the responsibility of attending to the organisation and co-ordination of curriculum implementation (cf. Brown and McIntyre, 1978).

Comparatively, this study has been comprehensive in terms of findings centred on the wider organisational set-up of curriculum implementation (as was Hamilton's study) and classroom interactions (as in Prophet and Rowell's study). The consequence of this is to view curriculum implementation as being shaped by internal and external constraints which were perceived and reported by teachers. The study is sympathetic to the wide-ranging challenges faced by teachers in handling the change. Placing the research findings in the wider context of the literature on curriculum implementation also located the study within a broader account of studies on curriculum implementation.

Again, Hamilton's and Prophet and Rowell's studies are useful as reference points. Hamilton's debates are based on the data which was also used as a contribution to development theory and on the modelling of curriculum integration. By contrast, Prophet and Rowell's approach, while similarly based on data, contains speculative interpretations. This study has attempted to link curriculum policy with classroom practice. It also provides a formative, interpretive and reflective account appropriate to educators (cf. Nunan, 1996; Anderson and Arsenault, 1998). This followed from both the rationale of the study and from the argument that, if research is to effectively contribute to improved understanding of the classrooms, then it must be *practical*. As Delamont (1976) notes, the concern with production of:

... immediately useful, practical results, rather than do 'pure' research ... has two main consequences ... [they are] the desire to improve teaching within the status quo of the traditional classroom, rather than question its basic premises, and the aims of establishing 'norms' for teacher behaviour rather than looking at each teacher as an individual (p. 104).

The above highlights the main thrust of this work. It has also been a very important consideration bearing in mind the centralised and large-scale implementation of curriculum in Botswana. It is argued that, any changes should be practical and should be a small adjustment which builds on the status quo rather than on being radical. This sets the study and its findings in a league different from Hamilton's and Prophet and Rowell's.

12.4.0 Conclusions of the Study

Several conclusions are derived from this study on curriculum implementation during its establishment phase. On the basis of research data, I conclude that:

- a) There were conflicting messages about the curriculum. It has not been clear if the new curriculum were about *maintenance* of an academic curriculum or about *change* to relevant education;
- b) The curriculum faced the threat of not being implemented by teachers, as they failed to identify and to convincingly and effectively deliver those key identifiable elements for the curriculum. The paradigm for the curriculum was lost in practice;
- c) The uptake of the curriculum by teachers depended on how directive and dominant the education system was about the curriculum. Teachers, the key instruments of change, lacked a sense of purposeful connection to the curriculum which perpetuated self-doubt regarding curriculum implementation;
- d) Within and outside schools, the structures were such that science teachers worked as individuals; this was not conducive to curriculum implementation. Thus, the implemented curriculum cannot be above the organisational and administrative structures it exists within;
- e) Overall, the whole effect of curriculum change and its implementation has been to alienate (variously) the pupils, who the Ministry have as the prime target group in the change process, from the education system, teachers and the curriculum materials.

In summary, this study showcases the importance of the management of change at its inception within schools if the linkage between the ideal and the implemented curriculum is to be developed. Curriculum implementation failed at four key levels. First, strategies for supporting implementation were virtually non-existent, so teachers were left to their own devices. This is a very serious oversight. Second, the organisational climate in schools was unsupportive, with teachers operating largely as individuals in departments which had nothing to do with curriculum development and implementation. Teachers were thus alienated from each other, the Ministry and the whole educational process. Also, any problems affecting the implementation process were left unattended. This resulted in a discouraging start to the curriculum and in a highly unpredictable future. Third, the meaning of the curriculum was unclear. At best, the curriculum reflected political values rather than an educational strategy. The paradigm of relating education to the wider social and economic climate, of using actual (lived) experiences as a basis for modernisation of the nation, proved elusive as a guide to curriculum development and

implementation. Finally, the curriculum was not a forceful change and it lacked authority. Furthermore, it can be said that the main purpose of making science accessible to pupils by manipulating teachers was unsuccessful.

What was significant, though, is the teachers' openness to change despite its imposition from outside the schools and its challenge to them. Also, apart from the technical difficulties within the teaching environment, the rhetoric of the educational policy failed to effectively link the syllabus, the teacher, and the pupils. Ironically, despite Botswana's massive investment in education and associated infrastructure, prospects of successful and effective curriculum implementation are rather bleak. In conclusion, the top-down methodology of curriculum change had a confusing and teacher-debilitating, student-alienating effect.

In terms of methodology, the illuminative capacity of the study founded in probing 'reality' about actual conditions that exist in schools has revealed a wide-range of issues which question the wisdom on which curriculum implementation is based. If the Ministry is true to its responsibilities, then changes must be effected sooner rather than later. This study fills part of the knowledge vacuum of where the problems lie. The study also should stimulate further research into curriculum implementation in Botswana.

.....

The End

APPENDIX 1

OVERVIEW OF BOTSWANA

This appendix presents some key aspects of the education system in Botswana and sets a framework for understanding concerns articulated in the study. Four areas are covered. A general overview of Botswana and the education system is given first leading to a discussion of mechanisms for education policy development in Botswana. The third and fourth areas cover development of science curricula in Botswana. This is seen in a historical context because the enterprise is still at a relatively nascent stage of development, seemingly discontinuous, and influenced greatly by political and socio-economic forces. A look into how curriculum developers transform education policies into curriculum leads to a general overview in Chapter 1 of the new science curriculum itself.

1.1.0 Physical and Demographic Factors of Botswana.

Botswana is a landlocked country in Southern Africa, sharing borders with South Africa in the south and south east; Namibia (former South West Africa) borders the country in the west; Zimbabwe is to the north east. The semi-arid country occupies some 582 000 square kilometres, approximately the same size as France and twice that of the United Kingdom. About two thirds is a desert which supports Botswana's beef industry and the diamond mining sector. The remaining one-third, which is to the east, is arable, relatively highly industrialised with good communication networks and essential social services.

At independence in 1966, the population of the country was about 500 000. The current population of the country is around 1.8 million with the majority of it concentrated in the eastern side of the country. English and Setswana are the country's two *official* languages. 80% of population speaks Setswana and 40% speaks English (Chemanne *et al.*, 1993). Both languages are used to varying extents as medium of instruction in schools though English is used at secondary and tertiary education. There are some problems, however, in using English as a medium of instruction particularly at primary and secondary schools. The language might be the third language for some pupils after Setswana and their mother tongue (e.g., Kalanga, SeKgalagadi, Afrikaans, SeSarwa) (see, e.g., Prophet 1990; Kupe and Diphaha, 1993; NCE, 1993).

1.1.1 Socio-economic factors and education

The rural areas are generally the least privileged in the country's economy. In the 1970s about 45% of the population in rural areas was below the poverty line (Moorsom, 1992) while half of the three million national herd of cattle is owned by 5% of Batswana households (*ibid.*; Brown, 1996). An up to date review of economy of Botswana is given by Vlaadingerbroek (1999). On the other hand, Botswana has three disparate socio-economic environments. They are: urban; semi-

urban and rural. Urban centres are relatively highly industrialised, cosmopolitan and have strong economies. Rural areas are near opposite of the urban areas though founded on a different social and economy system.

In terms of implementation of school curricula, the disparities in distribution of wealth could mean differences in: a) pupils' abilities, motivational levels, and aspirations; b) social, economic, political values on education. For instance, parental interest, aspirations and influence on education may differ across regions; c) ebb and flow of public opinion on education; and d) access to information and (provision) of resources. The issue has been recognised in the National Development Plan spanning the period 1979-85:

... there are significant differences in the quality of primary education , and therefore educational opportunities, between towns and large villages on the one hand, and smaller settlements on the other. Hence to increase and equalise the opportunities at primary level the government intends to provide schools for small communities and to raise the quality of primary education particularly in rural areas. Within the education sector, this will be the governments' first priority (Republic of Botswana, 1979, p. 99).

The state-run education system, managed by the Ministry of Education in the capital city, Gaborone, has to contend with the disparities in promoting and fostering literacy in the nation. Some of the key responsibilities of the centralised administration of education are:

- a) Recruitment, appointments, transfers, and training of teachers. Teachers are part of governments' resources for education (see Davies, 1988);
- b) Prescribed text materials and equipment are purchased and distributed by the Boipelego Education Unit, a government department;
- c) Examinations are the same for all schools irrespective of locality. They are all marked by teachers at a single centre under the auspices of the Ministry of Education;
- d) Enrolments and allocations of pupils to schools are controlled from the headquarters ensuring that no more than the required number of students progress from one key stage to another. For example, from primary to junior secondary school. The system also ensures that pupils gain admission to a school next to their previous one. Parental choice of schools for their kids is almost non-existent.

Ideally the centralised system is in principle also aimed at giving all schools within a particular key level of education parity of status in terms of funding, resourcing and development.

1.2.0 Educational Change and Policy Formulation

The study of appropriate education policies is crucial for understanding basic education, the school curriculum, including the nature of science curriculum and its implementation. The focus of the next section is therefore on establishment of National Commissions on Education in Botswana as a mechanism for change in education. This will be followed by a section which attempts to locate basic (i.e., relevant) education in Botswana in the wider context of similar policy initiatives both within Botswana and elsewhere.

1.2.1 Commissions on education

Changes in education in most African states accompanied the attainment of independence (see Ponsioen, 1972; Datta, 1987; Wandira, 1972; Crossley, 1990). The situation in Botswana (and possibly Lesotho and Swaziland) was, however, different. Three reasons explain the situation. At independence in 1966, Botswana was one of the poorest nations of the time with about one-third of its recurrent budget coming from Britain in the form of grant-aid in the 1970s (White, 1972b, p. 184). The poverty would not have supported major education reforms and developing the economy was the main objective. Another factor is noted by Hartland-Thuberg (1978). They note that:

... not every developing country is as fortunate as Botswana, which has escaped the inheritance of resentment toward citizens of a former colonial power. ... To have forced their own people into top-level policy positions before they were qualified would have meant plans less carefully developed, projects less completely studied, and proposals less thoroughly documented (p. 18).

This relates to the third reason that status of education at independence was not clear or defined.

In 1964, a team of experts from UNESCO wrote:

... the policy with regard to fundamental aims of the education system in Bechuanaland has not been redefined in recent years. It would appear however that the aims of education in Africa, promulgated in Command Paper No. 2374 of the Secretary of State for Colonies in 1925, still form the basis of educational policy in the protectorate (UNESCO, 1964, cited by White, 1972b, p. 184).

It was not until 1975 that the first commission on education was established following disquiet about the education system (Prophet, 1990; Kahn, 1989). The Commission referred to in this work as NCE-1976, started its work in January 1976. The Commission, working under the chairmanship of the internationally renowned Swedish educationist Professor Torsten Husen, consisted of equal numbers of mission-educated Botswana professionals (Kahn, 1989, p. 86) and foreign personalities (see Note 1). The Commission, appointed by the President of Botswana under Section 2 of the Commissions of Enquiries Act (Republic of Botswana, 1993), constitute the primary mechanism by which key educational policies are made. Its report, with some 156

recommendations, entitled '*Education for Kagisanyo*' was released in April 1977: *Kagisanyo* stresses mainly the principles of unity and social harmony (Prophet and Rowell, 1993).

NCE-1976 voiced concern that the then education system tended to alienate students from their cultural background and that it prepared young Batswana for white collar jobs. The situation was to be remedied through provision of education appropriate to the national needs and which should "orientate young people toward social, cultural, artistic, political and economic life of their unique society" (Republic of Botswana, 1977, p. 12). The education system had to be related to the cause of accelerating modernisation and development. The statement was significant in that it marked the beginning of consolidation of the independence of Botswana.

Self-reliance, along with the nations other three principles of Democracy, Unity, and Development, as in Tanzania (Hawes, 1979; Vulliamy, 1988), Ghana (Adams, 1983), Papua New Guinea (Bacchus, 1984), and across many other developing nations (e.g., Zimbabwe and Zambia) (see also Knamiller, 1984) became an educational aim. The principle has partially resulted in the new junior secondary curricula being related to the world of work and the pupil's daily lives. "Relevant education" (Sinclair and Lillis, 1980) is the term used in the literature to refer to similar policy initiatives. With the close alliance of education to the four national principles, the education system in Botswana played a great role in political socialisation of children through "transmission of values, beliefs, ideas, and patterns of behaviour pertaining to the generation, distribution and exercise of power" (cf. Datta, 1984, p. 38). The notions of unity and democracy foster in the youth what Lynch (1979) calls the "interdependent ideology" in which case:

... values such as those of cultural pluralism, the rights of others, and participatory democracy are related and tempered by the need for integration and coherence. The fostering of human relations is seen as central to the task of education and as comprising both the inherited and acquired potential to interact with other human beings in an effective and appropriate way (p. 66).

The report of the Commission was used extensively as the basis for shaping the education system. The first curriculum materials of the reform were implemented in both primary and junior secondary schools starting January 1986. Senior secondary education continued offering Cambridge Ordinary Level syllabi and examinations and was relatively left unchanged.

Two key changes were noted in the curriculum materials for junior secondary education. The first addressed the concern that the previous junior secondary school education was found to be too academic, not practical enough and insufficiently related to the needs of Botswana (Republic of Botswana, 1977; Rowell and Prophet, 1990). The curriculum had to be made *practical* (ibid.) so that students could be "exposed to a minimum of skill-orientation that will enhance their employability and self-employment" (Dambe and Chilisa, 1993). The new school curriculum thus geared pupils to:

... acquire skills in food production and arts for self-reliance, self-sufficiency and rural development; .. Effectively use commonly needed tools and instruments in activities connected with later studies and out of school operations (Dambe and Chilisa, 1991, p. 83).

Vocation-oriented electives of Art, Design and Technology, Religious and Moral Education in addition to Agriculture and Domestic Science, became part of the school curriculum. The second change was that of relating the curriculum to the cultural, artistic and political life in Botswana. A new subject called social studies consisting of national History, Geography, developmental studies and civics (constitution, electoral system, multi-party democracy and human rights) was introduced into basic education curriculum as the main subject for inculcating the ideals of nationalism in the youth. Social Studies replaced the traditional and separate subjects of History and Geography. There was also a shift in emphasis in all the traditional academic subjects such that their teaching had to be context-dependent or driven with themes, perspectives and examples drawn from pupils immediate environs. Core subjects namely, English, Mathematics and Integrated Science were "reviewed to give them an orientation to the world of work" (Republic of Botswana, 1993, p. 154). Appropriate school textbooks for all subjects disciplines were produced which also saw an establishment of several publishing houses in the country. The establishment of the colleges of education to produce citizen teachers for working at CJSS was also part of the wider changes in education. The changes were reviewed almost a decade later by another commission, the National Commission on Education of 1993, NCE-1993.

The Commission, whose chairman was the then Minister of Commerce and Industry, comprised 12 members, including three from Malaysia, Germany, and Singapore. This was meant "to give the work of the Commission an international flavour and experience of other education systems (ibid., p. i). The Commission built upon rather than made radical departures from the work of the previous one (ibid., p. 2). In that way the basic philosophy of education was not changed. Thus, NCE-1993 was concerned largely with access to education, structures for education, and in providing a framework and guidance for the expansion of the education sector. NCE-1993's strategy for education and training states that:

The Commission's strategy for the development of education and training over the next twenty five year is intended to address the problems in today's system and provide a way forward to the future. It is based on the fundamental assumption that the nation's major resource is its people and that investment on their education and training is a necessary condition of national development. ... Access to basic education is a fundamental human right. The Commission believes that education must develop moral and social values, cultural identity and self-esteem, citizenship and democracy. Its proposals for the future development of education have therefore been based on vision of society in the 21st century (Republic of Botswana, 1993, p. vi).

The statement basically reiterates the position of the previous commission. NCE-1993 invited submissions from members of the public and undertook a country tour to collect both oral and

written evidence. A total of 250 submissions were made by both individuals and various organisations; 14 research and policy studies were done; and external tours to 13 countries were undertaken. Two key points about the operations are noteworthy. First the data collection mode and reaching all sectors of the nation can be interpreted as seeking the mandate and support of the nation on what changes are to be effected. It was a way of giving the work and its recommendations a popular support. Second, in involving the nation in change through consultation, the Commission *displayed* accountability of the government to the nation.

Four findings of the Commission have relevance to science education. They are:

- (i) that the quality of science teaching in schools in Botswana is unsatisfactory (Republic of Botswana, 1993, p. 177);
- (ii) "there is a poor standard of mathematics and science amongst Botswana students throughout the country's education system" (*ibid.*);
- (iii) "the major deficiency in the provision of facilities is the absence of qualified laboratory technicians/assistants. This results in teachers having to attend to laboratory routines ... where instructional materials and facilities are available, they are poorly utilised, under-utilised or not utilised at all, due to the poor quality of teachers and insufficient laboratory support i.e., laboratory technicians/assistants" (pp. 177-80);
- (iv) there is a "shortage of local teachers at all levels of the system and in virtually all the science subjects. There are more than 15 different nationalities represented in the science teaching force and the high turnover provides very little continuity" (p. 180).

Quite clearly, the Commissions' work was based on *ad hoc* and anecdotal evidence such that much of what happens in the classroom did not inform policy decisions, recommendations and the curricula reforms that were effected after NCE-1993.

The Commission noted that there was poor articulation between and lack of continuity in curriculum offered at different levels of the education system (p. 179). This was in particular reference to senior secondary education which remained relatively unchanged since 1986 when major changes occurred at basic education level. The Commission recommended that the problem should be remedied through orientation of senior secondary school to the world of work, 'localising' the senior secondary syllabuses and examination which should be designed to cater for a wider ability group from the basic education level. The Ministry of Education made first attempts in August 1993 at marking some Cambridge "O" level examination scripts under the supervision of the University of Cambridge. The activity was part of the localisation exercise of education at senior secondary level. It is envisaged that Botswana will be in total control of the senior secondary curriculum by the year 2003 (Thuto, 1994, p. 8).

Following from the discussion of educational change in Botswana, the next section tries to locate the relevant education within similar programmes world-wide. This makes clearer the meaning of educational change in Botswana.

1.2.2 Basic education and relevant education programmes world-wide

The position of relevant education in Botswana within the wider context of similar schemes in the world is mapped out by focusing on three of its key features. First, in contrast to changes in Papua New Guinea (see Vulliamy, 1981a, 1981b) and in Tanzania (see Saunders, 1992; Saunders and Vulliamy, 1983; Crossley, 1990), the relevant education in Botswana is 'institutionalised education' with no community out-reach projects and deliberate productive and revenue-generating activities. NCE-1993 elaborates the position:

The Commission reiterates the broad principle that the JC [i.e., junior secondary education] curriculum should provide children with abilities they need for further education and training as well as equip them with living skills they need for a productive life. The purposes of junior secondary education, as part of basic education for all children, can be summarised as follows: firstly, to provide the knowledge and skills upon which further education and training can be built; and, secondly, to provide the competencies and attitudes for adult life and the world of work (Republic of Botswana, 1993, p. 155).

The relevant education programme in Botswana therefore aims at incorporating and teaching pupils 'practical skills' without the skills themselves being meaningfully harnessed in schools for the production of items for sale to the general public. Instead pupils' projects form part of their assessment both by teacher and external assessors from the Ministry of Education. This encourages pupils to have pride in their productive skills but may not break the 'literate bias' (after Saunders, 1982) of the school curriculum, and hence basic education. It also does not directly encourage 'participation in cash economy' (cf. Crossley, 1990; Sinclair and Lillis, 1980). In that way, the tension created by the dualistic nature of relevance programmes elsewhere, say in Tanzania and Papua New Guinea (see, e.g., Vulliamy, 1990d; Saunders, 1982; Crossley, 1990) is virtually minimised by the establishment though it takes different forms.

Secondly, the education has to be seen in the proper political context for Botswana, a capitalist state. Here it is appropriate to make reference to Patrick Van Rensburg's personal and pioneering initiatives in relevant education in Botswana which are widely cited and acknowledged in the literature. See, for instance, Van Rensburg (1970; 1986a; 1986b), White (1972a), Matshazi (1986), Knox and Castles (1982) and Vulliamy (1981a). Sinclair and Lillis (1980, p. 111) cite the initiatives as an example of the rationale-empirical approach to education. While his work is on relevant education, it is appropriately associated in Southern and Sub-Saharan Africa with the *Education with Production* movement, strongly associated with socialist movements in, for example, Zimbabwe, Zambia, Kenya and Tanzania. In essence, Van Rensburg's ideology of

education challenges the capitalist structures and orientations such as those in Botswana. He states that:

It is generally true that education systems serve societies in reproducing themselves and in ensuring continuation of particular socio-economic character and structures. ... A dominant feature of the capitalist socio-economic set-up is in its hierarchical nature. Its economic and employment structures are pyramidal and it is characterised by the division between mental and manual labour and the endless fragmentation of both into detailed specialisations. ... The classes within the social structure which organise and invariably control governments and ruling political parties, and which ensure that their classes and their allies retain control (1986a, pp. 74-75).

Matshazi (1986) explains the position further:

Central to his [i.e., Van Rensburg] thesis is the position that the economic and social structures and the educational systems that serve most societies today are marked by exploitation, inequality and hierarchy ... In his view, social transformation comes about only through a struggle in which the exploited identify their common interests and unite to change the social order, in that unity and struggle 'they gain a new awareness of themselves and of their power, and a new understanding of relationships of production' (p. 144).

The political motives and connotations implied in Van Rensburg's work do not go well with the government particularly as he is a prominent activist of a pro-socialist opposition party, the Botswana National Front led by the Soviet-educated Dr. Kenneth Koma. He used his principles to establish a secondary school, Swaneng Hill School, and the Serowe Brigades, a vocational centre.

The Serowe Brigade collapsed due to economic difficulties, internal conflicts on political aims and management policies (Knox and Castles, 1982). The Swaneng Hill School is now run by the government and offers conventional senior secondary school curriculum. But with the current relevant education scheme for Botswana which is within a pro-capitalist ideology (attempting to be politically 'neutral' and pedagogically sound), it does not support Van Rensburg's view of Education with Production. His work was fraught with classic problems of dual school curricula. His initiatives collapsed because students at secondary school level felt productive work disadvantaged them in passing their Cambridge "O" level examinations (Vulliamy, 1981a, p. 13) and thus indicating the how fatal lack of popular support for the dual education system could be (ibid.; Colclough, and McCarthy, 1980). The failure was also brought about by the fact that government-owned schools offered academic education only which had no manual labour (vocational) component. As Colclough and McCarthy (1980, p. 217) state, "the more congenial conditions prevalent in other schools acted as a paradigm for the students at Swaneng Hill School" (p. 217), Van Rensburg's brain child.

The third facet of relevant education in Botswana relates to the link of education with community. Relevance in education as in the case of Papua New Guinea attempted to orientate "the

curriculum towards the needs of the village community and the improvement of rural life" (Crossley, 1990, p. 141). While basic education in Botswana attempts to improve rural life it has not oriented the curriculum towards the needs of the localities which individual schools serve. As NCE-1993 found out:

There are significant problems in keeping a large and complex education system relevant to the community at large. The education system is part of the community which it serves and ways should be formalised to ensure that: a) there is consultation with and effective feedback from the local community; b) the community can influence changes in the curriculum and is aware of its influence and the changes when they occur; c) the community can play a role in resource mobilisation; and d) parents can play an active part in the education of their children (Republic of Botswana, 1993, p. 378).

As is apparent, a weak link between education and schools exists as the community does not have direct influence on policy decisions on education and the curriculum. The education programme is thus relatively detached from the immediate environs. Despite the differences noted between relevant programmes, there are similarities founded on what the changes in education in Botswana symbolised and meant. Here a brief overview which is Botswana-specific suffices.

Overall, the introduction of a basic education programme in Botswana created a second major episode in education after independence. The pre-1977 era was informed by the *dependency theory* while the post-1977 era showed marked influence of the *modernisation paradigm* (see Fagerlind and Saha, 1997; Lewin and Stuart, 1991; and Kahn, 1989, 1990a). Ball (1981) distinguishes roughly between the two paradigms. Under the dependency perspective the development of peripheral societies (nations) "is taken to be conditioned by dependence on and interaction with the metropolitan society though this definition treats dependency as a one-way relationship" (ibid., pp. 303-304) (see also Raggatt, 1983; McLean, 1983). The modernisation paradigm sees development of nation as an

... essentially harmonious, evolutionary process relying primarily upon changes in the central value system of any particular example, becoming modern involves first the massive and fundamental re-socialisation of the population (Ball, 1981, p. 302).

Consequent to changes in Botswana from dependency to modernisation theory, the official rhetoric of the basic education curriculum emphasised the following strands:

1. development of basic numeracy and literacy skills in youth;
2. fostering the spirit of national development and nationalism through school curriculum;
3. preparation of the majority of youth for adult life and world of work through practical curriculum;
4. to prepare the minority for education at senior secondary education level and beyond;

5. education for rural development through vocation-oriented curriculum that may result in self-employable and self-reliant youths, hence reduction of rural-urban drift of youth in search of jobs.

The above reflects that the country was faced with four inter-related problems: a) increasing population; b) low literacy levels; c) rising unemployment; and d) sluggish economy. After a decade (1986 - 1995) of implementing curricula changes in schools, they were terminated following the implementation of the recommendations of NCE-1993.

In the next section, a look at how the Commissions influenced curriculum development in Botswana is made. The influence of the Commissions is considered in view of the fact that NCE-1993 has not yielded new perspectives on which the understanding of the current science curriculum can be based. Thus, a historical overview of curriculum development is appropriate. The discussion of some of the key features of the curriculum, implemented in schools starting January 1996 is in Chapter 1. The focus is exclusively on science education within the basic education level.

1.3.0 Development of Science Curriculum in Botswana

The emphasis here is on highlighting the major characteristics of the process of curriculum development. Curriculum development in Botswana is still in infancy. It lacks both proper and specific models of curriculum development and appropriate professional personnel. From 1970s to 1986, the following characteristics describe the status of curriculum development. The first characteristic is captured by Lewin (1990a) in his statement that curriculum changes in developing countries were:

... merely built on existing syllabuses or weakly modified ... (and) frequently, adaptation concentrated on modifying the content without questioning very deeply the aims, the dominant views of the nature of the scientific knowledge and the prevalent conventional wisdom of the teaching methods (p. 4).

For instance, the adaptation of Nuffield Science in Uganda, Kenya, and Tanzania in the 1960's (Lillis and Lowe, 1987); the CHEM STUDY chemistry course from America was adapted for use in Queensland, Tasmania, and Western Australia (Ainley, 1978); the Scottish Integrated Science Project in Malaysia (Lewin, 1990d); in Zimbabwe (Kahn, 1986) as well as in Botswana, Lesotho and Swaziland in 1973 (Makunga, 1980). Haggis and Adey (1979) have compiled an extensive review of the adaptation of Integrated Science programmes in developing nations which provides more insight into the wide range of schemes adopted the world over.

The reasons for adaptation were numerous. For instance, amongst others, paucity of educational research on the African context and absence of personnel to provide alternative curricula definition or to produce data on which such definition could be based (Lillis and Lowe, 1987, p.

170): "There was little or no suggestion that there might be 'cultural' difficulties in using material originally from an entirely different context" (ibid.). The point is elaborately articulated by Ingle and Turner (1981)(see also Lewin, 1990a):

The effect of curriculum development in the third world over the past two decades has been to assume complete transferability in content and methods ... To step into a school science is to move into an atmosphere of cultural neutrality. The renewal of science curricula has been guided by the nature of the science to be taught and not by the context in which it is to be taught (p. 361).

The above points are well supported by a brief history of curriculum changes in Botswana. The development of teaching science at Junior Secondary School level in Botswana is relatively well documented for the period starting in 1970 (see Prophet, 1990; Yandila, 1992; Makunga, 1980; Nganunu, 1988). In 1970, the West Indian Science Project (WISP) was adapted for use in Botswana (Makunga, 1980). The use of the materials were short-lived following the appointment of a new education officer in the Ministry of Education as the incumbent advocated the adaptation of the Scottish Education Department scheme - "Science for the 70s" Integrated Science Scheme (ibid.). The scheme was published in Scotland in 1969 and followed in almost 90% of Scottish Secondary Schools in 1971-2 (Hamilton, 1982). The modifications to the science curriculum focused on the content and not on the context in which the curriculum was to be applied. The philosophical basis and assumptions (cf. Lillis and Lowe, 1987) were adopted wholesale. In that way, the key features of the "Science for the 70s" curriculum were preserved and became evident in the modified curriculum. The features were:

... its unification of physics, chemistry, and biology; its intention that the same teacher should take all the lessons for any given class; and its suitability for all pupils ... whether streamed or unstreamed. ... (it also intend(ed) that equal weight be given to biology, physics and chemistry within the unified whole; that the basis of the teaching be "stage-managed" heurism (or discovery learning); and that multiple choice examinations be used for testing the stated objectives of the course (Hamilton, 1982, p. 178).

Furthermore and, just like the "Science for the 70s", it was:

... portrayed as a self-contained system or curriculum package: in this case containing a set of pedagogical assumptions, a new syllabus, and details of techniques and equipment (Hamilton, 1982, p. 177).

The worksheets and textbooks produced as support material were accordingly modified and reproduced for use in Botswana (Prophet, 1990). The curriculum package was used in Botswana until the end of 1986 (Kahn, 1989).

The changes which occurred in school science in 1986 were a consequence of the recommendations of the NCE-1976. This was marked by presence in the Ministry of Education of a new team of curriculum developers:

From the onset, the syllabus details were developed by a team of subject specialists now equally composed of citizen and expatriate science educators. "Ownership" of the subject moved towards local hands. The positions of British advisers had been localised, and the above expatriate group was now dispersed across a range of nationalities. The dominant group consisted of citizens ... This was so despite the arrival in the ministry of a new foreign bloc, this time from the United States. This new bloc had not yet emerged in a leadership capacity, and it was in this vacuum that the new syllabuses were conceived (Kahn, 1989, pp. 89-90).

The new integrated science curriculum materials were modified versions of their predecessors but suited to teaching over a period of two instead of three years, in line with a change from the 7-3-2 to 7-2-3 configuration. A rather functional and pragmatic approach was pursued in "relating the syllabus to the local and contemporary needs and experience" (Nganunu, 1988). She states that:

We started out a session with approximately 20 teachers and science educators to list what science the individual needs to know for his/her everyday activities. We tried to identify common everyday activities in Botswana and then see what science is needed or useful for such activities. ... The initial reaction of the group members was that you can add new relevant-to-life material, but not remove anything from the traditional science syllabus. We had some heated arguments on whether you can go through life successfully without knowing "Hooke's Law". ... We also tried to find out areas of national interest and concern ... To find out more about these areas we paid visits to, collected materials from, arranged meetings and joint seminars with a variety of government departments and other relevant institutions. ... A small committee of three then sat down to write a draft for a detailed syllabus, which went forth and back to the larger group for comments (Nganunu, 1988, pp. 443-444).

Rollnick (1998) in her review of relevance in science and technology education in Africa, asserts that the change in Botswana was influenced by the Science and Technology in Society course from the United Kingdom. She states that:

with BOTSCI [i.e., Botswana Science], the country made a policy decision to teach a "science for Citizens" course at the junior secondary level, and to prepare future scientist and technologist at later stages of education. Science and Technology in Society (STS), a British course, influences BOTSCI, though it was impossible to adopt the highly contextualised STS materials. Where environmentally contextualised materials of this nature are developed, relevance means more than changing content or methods of teaching (p. 83).

Rollnick does not provide information of the nature of the influence and how it shaped the course. Her account does not challenge Nganunu's who gave an insider's view of events and forces that were influential in curriculum development. From Nganunu's position, there clearly was addition and subtraction from the previous curriculum of material on the basis of their perceived utility to the learner. Questions could be raised if official rhetoric of preparing the youth for the world of work and adult-life was adequately integrated into the curriculum. The changes were nevertheless symbolic:

This change reflects the reality facing the majority of junior certificate holders: there would be no senior secondary place for them to occupy; they would have to seek paid employment in town or return to rural areas. Accordingly a practical, relevant syllabus had become a necessity. Junior secondary was no longer a stepping stone to senior level (Kahn, 1990a, p. 158).

This is also reiterated by Nganunu (1988, p. 442) and in the 1986 science syllabus document (Ministry of Education, 1986, p. 1). There was also a notable change in the delivery system of the curriculum:

The syllabus is pupil-centred ... with a large and essential component of the practical work in a laboratory or science room making maximum use of easily available low cost material (Ministry of Education, 1986, p. 1).

A committee set up by the National Science Panel was charged with the responsibility of developing a cheap yet versatile science kit for Botswana. Experiences were learnt from Zimbabwe's 'Zim-Sci kit', developed for teaching with some success modified COSC science syllabuses in that country. The progress of the committee and the subsequent dissemination of the package to schools is explained:

The committee came up with a recommended total cost of US \$7300 per science room (laboratory). Our (referring to the National Science Panel) science programme owes much of its' success to the fact that the government at the same time, started a project of building or upgrading all junior secondary schools in Botswana. This included a simple science laboratory or science room and also covered the US \$7300 for science equipment. Hence we were able to provide the 'Botswana Science Kit' as part of the package of support materials (Nganunu, 1988, p. 447)

Furthermore, printed support materials were distributed to all schools with sufficient copies for every pupil (*ibid.*, p. 445). However, teachers' attitudes to low-cost material had previously been manifest in the use of Zim-Sci kit when used to ease the shortage of science apparatus in CJSS in Botswana. The kit was 'often derided' by teachers (Kahn, 1986). The Zim-Sci kit was an indirect outcome of planning under weak economy and IMF economic reform policies on Zimbabwe. Nonetheless, there was a promotion of mass access to education despite the country's limited physical and human resources for education (Graham-Brown, 1991, p. 107). The 1986 science curriculum in Botswana was not trial-tested because of lack of time, resources and shortage of personnel (Kahn, 1989, p. 90; Nganunu, 1988, p. 442). Kahn (1989, p. 90) also contends that the pressure of the time-scale implementation was, however, politically derived as was the case with its predecessor.

The implementation of the curriculum itself attracted relatively little or no research from educators or other people concerned with education in Botswana. The only available accounts by Kahn, Nganunu and Prophet were published early in the implementation of the change. Kahn and

Nganunu were at the time both members of the National Science Panel which participated greatly in the development of the curriculum materials.

1.4.0 Summary

With the use of Commissions as mechanisms for bringing about change, the following citation from Havelock and Huberman (1977) is appropriate to summarise the chapter:

... political leaders tend to feel that country's needs are clear enough and that the urgency of those needs requires immediate, large-scale action. Many of the appropriate solutions are also perceived as being relatively easy to arrive at ... There is a rapid cycle of planning, almost entirely in quantitative terms (number of staff required for cohorts of students, numbers of months necessary for production and distribution of materials, unit costs of hardware). Far less attention is given to likely constraints in implementation or even the precise amount and quality of local personnel and materials which would in fact be specifically available for this project (p. 90).

The introduction of materials to schools was also politically inspired. And as Havelock and Huberman observed in the case of formation of the British Open University in 1964 by the Labour Government: "the decision of the government to go ahead was in no sense a response to pressures from outside, or to public demand, it was a political act of faith, calling for determination" (p. 135). This leads to the development of research questions and the purposes and rationale of the study which are presented in Chapter 1.

Notes:

1. Some members of the Commission were:

Peter R. C. Williams, Institute of Education, University of London.

Dr. James R. Sheffield, Director of International Studies, Teachers College, University of Colombia;

Dr A. Habte, Minister of Culture, Sports and Youth Affairs, Ethiopia.

Dr. N. O. H. Setidisho, Rector of the then University College of Botswana and Swaziland;

B. C. Thema (the late), Member of Parliament and former Minister of Education;

(source: Tabulawa, 1997, p. 190)

APPENDIX 2

TIME-SCALE FOR CURRICULUM IMPLEMENTATION

The purpose of this appendix is to show how the school curriculum will change during its proposed five-year phase-in implementation. This is important because the study was done in the first three years of the five-year implementation plan. The plan locates the study within the time frame of the education changes.

According to the Curriculum BluePrint for the Ten Year Basic Education programme, the

implementation of the Three-Year junior secondary course will be phased in over a period of five years with complete implementation by the fifth year ... From 1996 to 1998, six core subjects and four optional subjects - Religious Education and Art under General studies and Home Economics and Design and Technology under Practical Studies will be offered. Each Student will be allowed to select one optional subject. ... In 1999 Moral education will be picked up as a core subject. Music and Physical Education, Commerce and Office Skills will also be picked in 1999. ... Principles of Accounts/Bookkeeping and Third Languages will be picked in the year 2000. This phased in implementation gives us full programme implementation by the year 2000 ... (Ministry of Education, 1995b, pp. 14-15).

The basis on which the time-scale of implementation was developed is likely to be more political than based on implementation capacity of the system.

The following tables summarise the changes in curriculum offered in schools starting from 1996 to the year 2000. The tables are organised according to categories of subjects with those offered in 1996-1998 acting as reference point to show the cumulative change over the years.

Core subjects (1996-1998)	Jan. -Dec. 1999	Jan. - Dec. 2000
English	1996-1998 subjects plus	1996-1999 subjects plus
Setswana	Moral Education	Design and Technology
Social studies		
Mathematics		
Integrated Science		
Agriculture		

Table A2.1: Proposed Cumulative Changes in Core Subjects

As table A2.1 shows, the five core subjects in 1996-1998 phase increase to seven in 1999 and eight in 2000.

The table below shows that the subjects for general studies increases from two in 1996-1998 period to four in the second phase and five in 2000. The same trend is true of practical studies (see Table A. 2.3)

General studies in 1996-1998	Jan. -Dec. 1999	Jan. - Dec. 2000
Religious Education	1996-1999 subjects plus	1996-2000 subjects plus
Art	Physical Education	Third Languages
	Music	

Table A2.2: Proposed Cumulative Changes for General Subjects

Practical Studies in 1996-1998	Jan. - Dec. 1999	Jan. - Dec. 2000
Design and Technology	1996-1998 subjects plus	1996-1999 subjects plus
Home Economics	Commerce and	Principles of
	Office Skills.	Accounts and Bookkeeping

Table A2.3: Proposed Cumulative Changes for Practical Studies

However, while such transitions were proposed, information on progress made so far is not yet available. The implications of introducing so many changes and electives into the curriculum have not been stated in the policy document. For instance, it is not clear how they will fit into the existing education set-up and whether all the subjects will be offered across all schools in Botswana. Another problem is the issue of time-tabling various subjects. The blue print shows how the time-tabling would be when full implementation is attained. The current subject curricula were designed and predicated on the basis of the situation when full implementation is in force.

The time allocations are shown in Table A2.4 below. The irony of the situation is that teachers were already complaining about time when they had six instead of five period per week for science teaching which would be the norm by the year 2000 and beyond. Overall the changes explain further the nature of the basic education programme for Botswana and the context in which the science curriculum is and will be implemented.

Subject	40 periods/week of 40 min.	45 periods/week of 35 min.
Core Subjects		
Moral Education	2	2
English	5	5
Social Studies	4	4
Mathematics	5	5
Integrated Science	5	5
Design and Technology	4	5
Agriculture	4	5
Setswana	4	4
Practical Subjects	2	3
General Subjects	2	3
Third Option	2	3
Guidance & Counselling	1	1
Totals	40	45

Table A2.4: Time Allocations for Subjects at Full Implementation Phase.

APPENDIX 3

TASK FORCE FOR CURRICULUM DEVELOPMENT

The purpose of this Appendix is to show the composition of the Task Force which developed the science curriculum. The composition of the Task Force was as follows:

Number	Occupation of Task Force Member
2	lecturers from the Department of Maths and Science Education of the University of Botswana;
1	person was from the Department of Secondary Education in the Ministry of Education;
4	science teachers: 2 from CJSS and 2 Others from senior secondary schools;
3	people were from Department of Teacher Training and Development. 2 were Secondary In-service Officers;
2	lecturers: one from Molepolole College of Education and the other from Tonota College of Education;
1	lecturer from a primary school teacher training college;
1	member was a primary school teacher;
1	person was from the Department of Primary Education in the Ministry of Education;
1	officer in the Examinations, Research and Testing Division in the Ministry of Education;
3	officers from the Curriculum Development Division.

Table A3: Composition of the Task Force

It seems the Task Force was meant to be a comprehensive and multi-disciplinary unit as most of its members were possibly appointed for purposes of providing first-hand information about operations of their institutions or departments and to highlight their stake (existing or perceived) or interest in the process of curriculum development. It appears, therefore, that the Task Force sought to develop a curriculum which linked well with most sectors of the Ministry of Education. The four lecturers were probably drafted in to provide professional guidance and leadership to the Force. Overall, the appointment of the Task Force highlights the underdevelopment of structures for curriculum development in Botswana.

APPENDIX 4

INFORMATION ABOUT THE RESEARCH SITE

This Appendix provides vital information and statistics for the research environment. The information, giving more insight into the environment, covers four areas. They are: enrolment figures, demographic data for teachers, school time-tables and time-frame for research. Each area is discussed separately.

4.1.0 Enrolment by School

The following are the enrolment figures for the schools. Pseudonyms are used to protect the identity of schools.

School	Number of Streams	Form 1	Form 2	Form 3	Total students	Excess	Class size
Mmirwa	18	209	217	196	622	nil	34.8
Motswakwa	18	231	229	240	700	nil	38.5
Mathata	18	272	239	266	777	32	45.3
Matiriki	18	240	238	162	640	nil	40
Mokwena	18	240	230	239	709	nil	40
Molete	18	243	224	243	710	3	40.5
Mongwato	18	203	231	162	596	nil	33.7
Sehutsana	18	254	232	237	723	14	42.3

(Source: Ministry of Education, 1998a.)

Table A4.1: Enrolment Figures for Schools

Note:

1. Mmirwa, Mathata, and Mongwato CJSS each had low Form 3 intakes because they became operational in January 1996. The schools were not fully ready for occupation early in the year. Also, being new schools in the region, they are all located on the outskirts of the village where there is no public transport. Hence, according to one deputy Head, some parents withdrew pupils some of whom had since been admitted to Mathata and Sehutsana CJSS.
2. Form 3, 2 and 1 are, respectively, cohorts which began the study of the curriculum in 1996, 1997 and 1998. Form 3s were in their last year of the curriculum. The group sat the first examinations of the curriculum in December 1998.

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2. * Denotes science teachers who deputy Heads and taught at most 12 periods (i.e., 12 x 40-minute periods) due to shortage of science teachers;
3. Table excludes five new teachers who arrived in January 1998. Three were new graduates and two were qualified teachers on transfer from other schools. Two of the three new teachers were based at Mongwato CJSS where they taught both math and science. However, the deputy Head did not relinquish the classes he taught in order to keep teacher loads low.
4. Three expatriate teachers, working in schools were not included in the research sample. One had been teaching for less than nine months (a volunteer) and her contract finished in December 1997; another was anticipating transfer to senior secondary school with effect from December 1997; another one came in January 1998, from a senior secondary school.

All but seven (inclusive of the three deputy school heads) of the 26 teachers who participated in this study held a Diploma in Secondary Education and were trained to teach at junior secondary school level. The three-year training was done at either the Molepolole College of Education (MCE) or Tonota College of Education (TCE), opened in 1984 and 1990 respectively as part of a package of the CJSS programme. TCE not only increased the output of teachers for all subject disciplines but provides subject disciplines (Agriculture and domestic Science) which are not available at the other college. Teacher's from the Colleges were each trained to teach dual subjects. Any combination of subjects could be drawn from Social studies (civics, history, and geography), English, Art, Setswana, Science (Biology, chemistry, physics), Mathematics, Religious Education and, with the opening of TCE, Home Economics and Agriculture. However, all but five teachers in the study taught only science. The five also taught mathematics though the bulk of their teaching load was from science.

The two colleges are non-degree awarding and produce only the Diploma in Secondary Education holders, resulting in near homogeneity of qualifications among CJSS teachers. Also, a shortage of degree holding teachers in the rapidly expanding senior secondary school establishment resulted in a very insignificant number of degree holders working in CJSS, particularly and primarily as school administrators.

The single largest age group is that which fell into the 25-30 category and had 1-5 years of teaching experience. Its high incidence is due to the young and rapid country-wide expansion of the CJSS establishment. This has seen experienced teachers with more than seven years experience being promoted to leadership positions to schools across the country. Also, experienced teachers who were former holders of the University of Botswana Diploma in Secondary Education have since 1990 been sent away for further training and were later

committed to senior secondary schools where their qualifications are sought. The opening of TCE in 1990 was also meant to fill the void created by the rapid upward mobility of teachers.

The next section shows how the teachers were engaged in science teaching. This is done through two typical time-tables.

4.3.0 Timetables for Teachers.

Within schools, time as a resource in implementation of the curriculum was dispensed away with in a similar pattern, though it is anticipated to change over time (see Appendix 2). All the schools in the study followed a timetable in which a day comprised eight blocks of 40-minute duration each, referred to as periods. Consequently, a five-day timetable had 40 periods, while a seven-day one had 56. In case of a five-day time-table, science had six periods but paired into three lessons of 80-minute duration. On the other hand, the time allocated for science teaching was different in seven-day time-tables. In one case, all Form 1 classes had seven periods while Form 2s and 3s had eight periods each in a seven-day cycle.

Two examples of time tables teachers are produced below. One is for a teacher in a school following a five-day time table, while the other is for a seven-day time schedule.

4.3.1 Five-day timetable

Name: Mrs X

Subject: Science

Term 1

Day	Period 1	2	Break	3	4	T/Break	5	6	Break	7	8
Sum. time	0705-0745	0745-0830	5min	0835-0915	0915-0955	0955-1025	1025-1105	1105-1145	1145-1150	1150-1230	1230-1310
Mon.	2C	2C		3A	3A	B				3E	3E
Tues.	3B	3B		2A	2A	R	3A	3A			
Wed..	2C	2C		2A	2A	E	3E	3E			
Thurs.	3A	3A				A	3B	3B		2C	2C
Friday	3E	3E		2A	2A	K				3B	3B

Total load: 30

Table A4.3: An Example of a Five-Day Timetable

Notes:

1. Some time tables would contain room numbers;
2. The two five-minute breaks between lessons is meant for pupils to visit toilets, often located some distance from classes. The break was also for them to deposit and collect some books

from their lockers in preparation for next batch of periods. Some schools did not have such the breaks;

3. The timetable is for summer and the times are generally adhered to by all schools within ± 10 minutes.
4. All individual classes (e.g., 2A, 3B) each had a total of six periods in a week.

4.3.2 Seven-day timetable

Seven-day timetables had eight periods per day just like the five-day ones. But as explained, they were based on a seven day cycle such that pupils followed the same set of lessons after every 7 days (i.e., on the eighth day)

SEHUTSANA COMMUNITY JUNIOR SECONDARY SCHOOL. TIME TABLE FORM

Teacher's Name: Mr Z

Subject: Science

Classes: (see time table)

Total Weekly Load: 46 periods

Day	Period 1	2	Break	3	4	T/Break	5	6	Break	7	8
Sum. time	0705-0745	0745-0830	5min	0835-0915	0915-0955	0955-1025	1025-1105	1105-1145	1145-1150	1150-1230	1230-1310
Day-1	1B	1B		3D	3D	TEA				3E	3E
Day-2	1A	1A		2E	2E	B	2F	2F			
Day-3	3D	3D		3E	3E	R	2F	2F		2E	2E
Day-4						E	1A	1A		1B	1B
Day-5	1A	1A		2E	2E	A	3E	3E		2F	2F
Day-6	2E	2E		3D	3D	K	2F	2F		1B	1B
Day-7	1B			3E	3E		3D	3D		1A	

Table A4.4: An Example of a Seven-Day Timetable

Notes:

Unequal distribution of periods is noticeable in the above. All Form 1 classes had a total of seven periods; Form 2s and 3s had eight lessons per cycle. Typically, this resulted in teachers being engaged for a total of 46 out of the possible 56 periods in the seven days. Also, unlike in the five-day timetable, it could some time before a class meets the teacher again. The impact of this on concept development has not been investigated.

Below is a detailed time frame for research. An abridged version appears in Chapter 3. The time frame for research is presented here because it was determined by the research environment. For

instance, the duration and period of school terms, vacations and other organisational factors in the schools dictated the time available for research and how it could be used.

4.4.0 Time-frame for Research

The overall time-frame for the research shows how the available time was expended away with. It shows key events and episodes in the research process in the field. Only the key activities are indicated against the corresponding period in the fieldwork.

May 17th 1997: Permission to undertake the study in schools in Botswana is sought from the 8 School Heads and the Permanent Secretary in the Ministry of Education, Gaborone.

July 17th 1997: Departed from York to Botswana to prepare for fieldwork.

Aug. 13-14th 1997: Physical follow-ups of requests. Meetings held with relevant officials in the Ministry of Education and later with individual school Heads.

Submission of an application to the office of the Deputy Vice Chancellor (Academic Affairs) at the University of Botswana for a comprehensive Research Grant. P8000.00 (approximately £1200.00) was approved and made available for research. The grant was administered by the Bursar's Office at the University.

Sept. 8th 1997: The last and third semester of schools began in Botswana. Phase 1 of fieldwork started in the earnest after the collection of time-tables from schools.

Oct. 17th 1997: Dispatched (e-mailed and faxed) a 'progress report' to my supervisor in York. The report had 3 samples of completed observation sheets; a preliminary overview of noted trends, identification of problem areas and reflections on the study. The report marked the end of what could be seen as a pilot phase of the fieldwork.

Nov. 11th 1997: All schools start their end-of-the-year school-based examinations. Teachers at Molete CJSS were unavailable for classroom observation and interviews due to the examinations.

Temporary withdrawal from the field for more data analysis and reflection on project began. Four interview transcripts were word-

processed in preparation for consultative meeting with supervisor in Pretoria (details are given below).

- Nov. 28th 1997:** Schools closed down for a six-week Christmas vacation.
- Dec. 20th 1997:** University of Botswana, my 'office-base', closed down for business and re-opened on 5th January 1998. I took a break during the vacation.
- Jan. 12th 1998:** Beginning of the 1998 tri-semester school calendar. 12-16th January 1998 - registration formalities for new pupils. Collection of school timetables suspended as they were still being drafted. Some teachers on transfer from other schools had not reported to their new schools.
- Jan. 14-17th 1998:** Attended the 6th annual SAARMSE conference held at the University of South Africa (UNISA) in Pretoria. SAARMSE is an acronym for Southern African Association for Research in Mathematics and Science Education.
- Meetings for reviewing my fieldwork progress were held with supervisor at the Conference. A meeting was also held with Prof. Ogunniyi of the University of Western Cape, who has immense experience in working in Botswana where he had lecturing duties with the University of Botswana. Discussions centred on his critique of my research proposal. He also gave practical guidance on researching in Botswana.
- Jan. 17th 1998:** Phase 2 of school visits started.
- Apr. 15th 1998 :** 1st term of schooling ends after the Easter holidays. There were no school-based examinations this time.
- May 6th 1998:** Meeting with Inservice Officer of the region; Collection of documents from Ministry of Education. Informal visits to schools. Gradual withdrawal from the field and expressing gratitude to teachers and schools for participating in the study.
- May 19th 1998:** Submission of the second and final comprehensive report for expenditure to the Bursar, University of Botswana. The first report was submitted on 30th January 1998. That had been done for purposes of accountability as well as for the release of the last half of the Research Grant.

June -August 1998: Three month rest and break away from the data.

Sept. 8th 1998: Returned to University of York for data processing.

The data processing took up to three months before the write-up of the chapters for the research findings began in January 1999.

APPENDIX 5

DATA SOURCES

This Appendix comprises two sections. The first section contains four samples of lesson observation recordings. The other section is an inventory of the various materials from the field and were available for data analysis.

5.1.0 Lesson Observation Recordings

This section comprises four individual complete samples of lesson observation recorded. They are meant to fulfil a number of objectives. First, the samples are mainly meant to give readers a 'feel' for the classroom environments in which the research was done. Second, they also illustrate progressive focusing in observation which is illustrated by the level of detail between samples. Sample 1 shows how detailed some recordings were but, with the apparently high predominance of questions set at recall-level at beginning of lessons, level of detail was accordingly reduced later. Third, reflective comments highlighted through bold prints (i.e., as **Comment**) in each sample, demonstrate how they were used to preserve the links between the various parts of a lessons or, made specific observations relating to the implementation of the curriculum itself. Fourth, each sample reflects a diversity of experiences and transactions in classrooms, each contributing to the wider understanding of the implementation of the curriculum.

Excerpts from the samples appear particularly in Chapter 5 and 6. Complete recordings are given here so that the excerpts can be seen in proper contexts. The samples are numbered and presented as Sample 1 to 4. Sample 1 is on lesson on "Ecosystem". A lesson on "Blood Circulation" comprise Sample 2. Lessons on "Plant Reproduction" and "Making Water Safe" are Samples 3 and 4 respectively. The transactions in the samples are written in present tense.

SAMPLE 1

The Form 2 lesson is on Ecosystem. Recordings were reasonably highly detailed throughout the 80 minute teaching session. The source identification code is (Rak, Observation, File 7)

08:25 Beginning of 3rd period. Teacher introduces the researcher to the class.

Teacher: 'Did I give you homework?'

Pupils: (in chorus) 'No'

Teacher: 'I told you to read the textbook, didn't I?'

Pupils: 'You did!'

Teacher: 'Isn't that a homework?'

Pupils: (laughing) 'Sort of!'

Teacher: 'What did we talk about last time, mmmh?'

Pupils: 'Food Chains'

Teacher: "What type of organisms make up food chains?"

Pupils: 'Producers and consumers'

Teacher then touches on a number of topics, amongst them photosynthesis, energy storage, producers and consumers - their roles and respective positions in the food chain. The concept of feeder levels is also covered.

8:37 Teacher then gives an example of a food chain to demonstrate the place of consumers and producers within it. The example includes grass, antelope, lion, and vulture, all arranged according to 'feeder levels'.

Comment: similar examples appear, respectively, on pages 121 and 178 of Books 1 and 2 of Science by Investigation in Botswana.

Teacher: "What does an antelope need energy for?"

Pupils: remain silent.

Teacher gives pupils prompts to cue them into figuring the answer to his question. Still no answers came from the pupils. 3 pupils were called on by their names but remained silent.

Comment: To this point, there has been minimal or no variation of teacher activities. No writing on the board. No teaching aides.

Teacher finally gives an explanation, then asks:

"Are we all clear about this?"

Pupils: "Yes, sir!"

Teacher: "Any questions so far? It is a revision of what we did last time, isn't it?"

Pupils: "It is!"

08:41 Teacher: "How many grasses can an antelope feed on?"

Pupils: (in chorus and speculating) '3000 4000 grasses!"

Teacher: "How many vultures can eat a lion?"

Pupils: (speculate) "1, 2, 3, ... etc." , amidst mumbling and disbelief/disapproval by some pupils.

Teacher explains the logic of his questions: That, there is a decline or decrease in the number of organisms consumed at various levels of the food chain with producers being available in abundance at the bottom of the chain/food pyramid.

Comment: I did not get the reason behind this exercise until I realised that it was meant to generate data for developing a food pyramid! The idea seemed lost in the presentation, right from concept to development.

08:49 Teacher asks: "Are we clear on this?", after introducing and lecturing on the concept of pyramid of numbers.

Pupil: (in vernacular language) "A tau yone a gae jewe ke diboko?" - meaning "Is the lion itself not devoured by maggots?"

This was asked with reference to the food chain, the (seemingly) linear model placing vultures between the lion and maggots. Pupil probably sought clarification on this as the model tended to defy logic.

Teacher translates the question to English. Teacher leads the discussion of question by way of simple but leading questions. Pupils give chorus answers in both English and Setswana. Answers are met with approval though the diagram which was the basis of the discussion was not modified.

Teacher: "What is a pyramid of a biomass?"

Pupils remained silent.

Teacher then explains biomass as "the amount of living matter in an ecosystem". This is all the teacher said before asking the question once more:

"What then is the pyramid of biomass?"

Teacher: "Yes, Rebaone, give an answer to my question!"

Pupil: Rebaone remains silent.

Teacher: "Come on think. You can't tell me you do not know the answer. Emmanuel, Kedibonye say something!"

Comment: Teacher embarks on direct questioning - there was no evidence of a (proper) introduction of the concept to pupils - this probably reflects his expectations based on the reading exercise he gave the pupils in advance of this lesson. Remember that he inquired at the beginning of the lesson if pupils had read.

08:56 Faced with a difficult situation, the teacher attempts a demonstration on the board. The example is not working either and teacher acknowledges this:

"Our example is not going to give us the right thing!"

The teacher lectures, revisiting the concepts of food chain, food pyramid, biomass, and pyramid of biomass, in that order. This was terminated with a question: "Are you clear about that?"

Pupils: "No!"

Teacher: "Are you clear about that? Do you understand pyramid of mass? Did you get it? Did you get it ? (repeated and shouted at pupils)"

Pupils: (maintaining their resolve) "No, teacher!"

The teacher, now with bit of temperament and annoyance retraces his story, distinguishing between pyramid of numbers and biomass.

Teacher: "Do you have any problems?"

Pupil: "No, teacher!"

Comment: The pupils' answer was a tactical one inasmuch as the teacher's question was. Reading his mood, and probably from experience, pupils knew that answering in the affirmative would have saddled them with the burden of articulating their problems. And, for the teacher, it was a way of passing the ball into the pupils' court - not that he expected much from them, but as a divide and rule strategy: this is the message pupils in other classes elsewhere seemed to know well.

09:02 Teacher (looking relieved): "OK! Imagine you have a small pond . You have small organisms in there - frogs, *dikoduntwane* (tadpoles). Now let us talk about the food web of the pond. What other animals are there?"

Pupils: give a list of animals and the teacher himself constructs a food web. The examples given include: octopus, seal, starfish, limpet, seaweed, fish.

Comments: a) Note the contradiction - teacher has a different picture of pond - pond as in typical Botswana setting, hence his two examples of animals. Pupils have their own "ponds" in mind which, I am led to believe by their examples, equate to a lake, or even a sea. b) Teacher does not query this as it is consistent with his expectations following from the reading assignment! On checking in class through copies of my textbooks, I found the example to be from page 40 of Science to 14 textbook. c) Pupils are not involved in developing the food web! d) The casual introduction of food web should also be noted.

Teacher uses 'his creation': "Food web is the flow of energy. If we remove the limpet from the web, what will happen?"

Pupil D: "Organisms that feed on the limpet will die from hunger."

Teacher: Correct ... and the starfish will die from hunger. What else will happen?

Pupil E: "Seaweed will increase in number."

Teacher: (thrilled) "Yes, this is simple. Imagine *re ko lwapeng* (... we are at home). If the supplies of rice, beans, sugar, etc. run out, what implications will it have?"

Pupils: Remain silent

Comment: example probably eludes them.

Teacher: "You change your diet patterns. You will look for more of foodstuffs available in the home - it is a matter of survival ... What I want to get to is that whatever happens to one organism in the food web affects other organisms"

Teacher then revisits the food web of the pond, perhaps as a way of cueing the learner into thinking. This is concluded with the question: "Do you all understand?"

Pupils: "Yes!" (Teacher smiles).

Comment: The example on the ecosystem of the pond given above was under-utilised in the lesson as it was probably mainly convenient for introducing the concept of food web. Its value in developing the concept further was not explored. The concept of a food web as a flow of energy seemed to exist in isolation as the examples given never sought to make use of the definition.

Teacher: "Is there any question so far before I give you something else to do?"

Pupils: "No, teacher!"

09:19 Teacher: "Let us take down notes"

09:32 Teacher: "Are you finished?"

Pupils: "No!"

Teacher: "Tomorrow we are going to talk about adaptation. I will borrow you these books and read pages 174 and 193. You can make your own notes. Work in pairs as we do not have enough books. You should find the topic easy because you have done adaptation in your social science classes. ... We will be looking at adaptation from a scientific point of view ... On Thursday, you will write an exercise on communicable diseases as well as light"

09:40 Class becomes noisy as the pupils finish the writing exercise. The notes seemed to have been made to last the remainder of the teaching session.

09:40 Bell rings, class disperses.

SAMPLE 2

The topic of the Form 1 lesson was Blood Circulation. (The source identification code is Mau, Observation, File 9)

08:40 Class has just settled in. Teacher starts by asking questions on blood circulation:

"What is the difference between an artery and a vein, Malebogo?"

Malebogo does not answer, remains silent.

Teacher admonishes her saying that her performance has declined since she move to the back of the class. Teacher says that he had thought her performance would improve now that she is seated amongst boys!

Revision goes on with questions asked by the teacher.

08:47 Teacher introduces the topic of the day: DISEASES OF THE CIRCULATORY SYSTEM. Teacher requests examples of the diseases from the pupils. Pupils shout out at will: 'Stroke! Heart attack!' 'What else?', says the teacher with his back to the class, and in response to the momentous silence. Pupils continue: 'Aids, Anaemia ...'

Teacher tells the class that they will discuss the diseases starting with the *common one*, 'AIDS'.

Teacher asks questions requiring factual recall on AIDS and does not elaborate on them.

Comments: a) pupils have probably done something on sexually transmitted diseases hence their seemingly good supply of answers on Aids. b) Teacher's perceptions are impinging on teaching: why should he label Aids as the *common one* ? c) Note the time taken to change to the new set of topics.

08:53 Teacher: "Another disease of the circulatory system is anaemia".

Teacher then asks questions to which pupils respond to rather poorly. Teacher retorts: "We have covered all the functions of blood, haven't we?"

Comment: the teacher expects pupils to make a connection, unassisted, with what was done previously.

Inspite the poor performance, the teacher does not revisit the functions of blood but goes on to write notes on the board on anaemia. Haemoglobin is introduced to pupils during the course of the activity. Teacher then pauses to read the notes on the latter part; no questions came from either side.

Teacher: "Has any of your parents suffered from any of the diseases we have covered so far?"

Pupils remain quite and the teacher turns to the board to write more notes on anaemia. Pupils start making noise. None of them seem to

have interest on what the teacher writes on the board - they do not even transcribe the notes.

- 08:59 Teacher writes STROKE on the board to indicate change of focus in teaching. Teacher goes into the store-room, albeit briefly, and returns to say that the focus will now be on HEART ATTACK instead of stroke. I notice the teacher has a model of heart in his hands. This could be the reason for the change!

Once more, the teacher lectures to the pupils and very little done in terms of involving pupils in concept development, stimulating their thinking, and soliciting their knowledge.

- 09:10 Teacher writes notes on the board. Pupils remain idle. The next sub-topic is STROKE. Teacher takes it upon himself to explain stroke and the difference between the latter and heart-attack.

Teacher tells the pupils that it is "unhygienic" (sic) to stand for a long time as the blood may not reach the brain which may lead to fainting. Later, he asks the following question, related to one of 'consequences of stroke' appearing on the board:

"What do we mean by paralysed?"

Pupil 1: "It means a person cannot see"

Teacher ignores the response and nominates another pupil to answer:

Pupil 2: "It means not being able to move"

Teacher seems disinterested in the response and says:

"Have you ever seen people in wheel chairs? It is because of paralysis. They cannot move."

Once more the teacher writes notes on the board; pupils remain idle and chat amongst themselves.

Comments: The pupil's explanation is ignored despite being close to the one the teacher supplied. The term 'paralysis' was not explained or defined.

- 09:22 Focus shifts to listing some of the causes of heart attack. Pupils make virtually no contribution to the list which includes: smoking; eating too much fat or salt; lack of exercises.

Teachers announces that the next activity is note-taking.

Comment: Now it appears clear why pupils have not been taking notes simultaneously when the teacher wrote them on the board: they were waiting for a command!

Pupils pose questions to the teacher.

Pupil A: "What is the difference between fat and oil?"

Teacher: "Fat is a solid at room temperature while oil is in liquid state at the same temperature. That is the main difference"

Pupil B: "Is there anything like vegetable oil?"

Teacher: "Yes, oil from peanuts, linseed oil, sunflower ..."

Questions are finished. Pupils start writing notes, making noise as they do so. Some complain of one student who has moved to the front of the class, closer to the board, perhaps because of poor vision.

Comment: a) Teacher's distinction between fat and oil appears superficial; b) Pupils' questions show that at least they have some interest in the topic. c) Teacher possibly either sees himself as the sole authority of knowledge or lacks skills in involving pupils in answering questions.

09:45 Teacher announces to the class that the Circulatory System is covered in Book 2 and that the books will be lent out to them for revising for a test.

Taking notes continues unsupervised.

Comment: Taking notes appears to be a fill-in activity. Why are they reserved for the last one-fifth of the teaching session?

10:00 Bell rings; end of the 80-minute teaching session: Time for a 30-minute tea-break.

SAMPLE 3

The lesson involves a Form 1 class, and the topic of the lesson was Plant Reproduction (Source: Mar, Observation, File 4).

07:10 Class delayed because of morning assembly. The teacher, being an assistant headmaster, got delayed as he had to attend to a few problem-cases of late comers.

07:32 Teacher sends pupils out to collect flowers before starting with teaching. Teacher greets class.

Teacher: "Yesterday we started a topic on sexual reproduction. I asked you to draw a flower and label it. So can someone volunteer to make a drawing on the board and we will label it together as a class so that there is consensus on the parts of the flower".

One female pupil volunteers to do the drawing.

07:36 Teacher: "OK, there is our flower. Now let us label it"

Teacher calls out the parts - petals, sepals, stigma, ovary, filament - and picks on different pupils to indicate and label them on the board.

07:40 The labelling ends and the teacher instructs all students to do corrections in their notebooks.

Observation - There were no corrections made by the pupils: they probably had copied the diagrams from page 49 of Chalebgwa *et al.*'s textbook.

Teacher continues: "We have male and female reproductive parts in flowers. Shall we start by labelling the male organs?"

Pupils this time give the names of the parts: Stigma, pollen grains, anther, filament. Thereafter, the labelling the female parts followed: Pistil, ovary, ovules etc.

07:43 Teacher: "There are the two important parts. Now take your flowers, remove the petals and stamens so that you expose the female reproduction parts. I want you to draw them".

This instruction is repeated, albeit paraphrased.

Pupils oblige to teachers instructions. They work collaboratively in small informal groups.

Teacher appears to supervise the activity and talks to individuals or groups of pupils.

Teachers tell the class to use sharp pencils and not to shade in the drawings.

Comments: a) note the speed at which progress is made - probably reflecting the combined efficiency and efficacy of giving pupils reading assignments in advance of lesson and using simple questioning skills; b) Pupils do not start off by using the real flowers

they brought into class but they deal first with that in the text; c) There wasn't a single pupil who failed to answer a question correctly.

07:59 I visit a group amongst the first to be visited by the teacher. The question posed to them is:

"What guided you in labelling the stamen the way you have?"

Pupil: "I can't get your question ..."

Researcher: "How did you get to know that these parts (pointing to the labelled diagram) should be labelled stamen, anther, filament?"

Pupil: "I got this from Mr X (the teacher). He told me to label them as such".

Comment: Some pupils did the labelling without a 'good starting point' and relied on the teacher. This could be a mechanical activity as little or no thought is put into the exercise. On the other hand, no hand lenses were supplied to help pupils see easily some of the smaller parts of the flower.

08:19 Teacher: "OK, can we settle down and talk about the flower What is the use of the flower? Why do *plants* need petals?"

Pupil J: "They need petals to attract insects".

Teacher: "Do all *plants* have petals?"

Pupils: (en masse) "No!"

Teacher: "How can you explain that?"

Pupil K: "There is self-pollination and not cross-pollination!"

Teacher: "Phew!, you are touching on new terms that we haven't covered yet. Let us shelve that for the time being. Now what colour are the petals?"

Pupil L: "They are brightly coloured to attract insects!"

Comment: a) The pupil got the response from the textbook: it does not seem to matter to her that the flower she had had yellow petals. Nonetheless, the teacher approved the response without concern over the discrepancy. It could be that it is not clear which flower is dealt with - the general one in the book or, the one right before the pupils and used in the mini-practical.

Discussion of parts of the flower continues with the teacher complaining constantly that pupils are steps ahead, giving answers which are relevant to questions yet to be asked. Teacher feels out-paced by his students.

Teacher: "Some pupils are eight steps ahead talking of fertilisation while we are still talking of parts of the flower".

08:30 Teacher lectures on cross-fertilisation and gives an analogy to send the message home:

"Even at home you are not allowed to have a baby with your brother or sister ... Can you have a baby with you brother/sister?"

Pupils: (in chorus) "Yes!"

Teacher smiles, perhaps in disbelief, and repeats the question.

Pupils: "Yes, we can!" (louder than before).

Teacher: 'I can't deny that it is possible but it is not allowed for various reasons. The same applies to plants ...'

Comment: The subject was not discussed thereafter raising questions about the purpose of the analogy in explaining cross-fertilisation. It could be that he had thought to capitalise on the moral aspects of the issue. They are such that pupils should answer to the contrary and thereby in line with his position. The fact that pupils were defiant and adamant that their position was valid meant that he had hit a dead-end as he emerged least ingenuous in turning the unexpected to his advantage and to the benefit of the class.

08:40 Bell rings - end of the lesson.

Teacher: "OK, we shall continue from here next time".

Comment: Even though the question and answer technique is heavily utilised by teachers, the skill of developing questions and of using them effectively in concept development is somewhat underdeveloped. Responses from pupils, mainly restricted to supplying facts, have appeared to be of little worth insofar as concept development is concerned. They do, however, give the teacher a 'smooth ride' as this more frequently than not cushions him/her from the rigours of teaching.

SAMPLE 4

The Form 2 lesson is on Making Water Safe. The peculiarity of this lesson is its lack of coherence. This was possibly due to the fact that techniques on water purification were covered at Form 1. The source identification code of the lesson is (Pon, Observation, File 6).

I arrived late at 07:25. Classes begin at 07:20. Being the first period of the day, and having just been released from the morning assembly, most pupils are still at their lockers collecting their books for the first four periods of the day.

- 07:35.** With all pupils seated, teacher greets class and starts a question and answer review session of filtration. Teacher draws a diagram of a set up of a simple filtration experiment. Pupils assist in its labelling.

Teacher then introduces the concepts of residue and filtrate.

- 07:40** Pupils are instructed to transcribe the notes into their note-books. Teachers walks around the class, seemingly supervising the activity.

Comment: The set up (i.e., drawing) is the same as that in one of the textbooks ubiquitous across the schools. In one school, a pupil defined filtration as: "the separation of mud from water". I could now see that an experiment identical to the one in this lesson had probably been used in that particular school.

- 07:53** Teacher writes additional notes. He introduces the concept of sedimentation to pupils through the notes. It has not yet been discussed in this lesson.

Comment: I leaned over to the pupil seated next to me and learnt that the experiment was done the previous day, hence the speed.

- 08:03** Teacher instructs a pupil to erase some of the notes on the board.

The teacher then lectures on sedimentation. Pupils were not asked any questions. they appeared attentive, though.

Teacher tells pupils how wood ash can be used at home to reduce/settle sediments in impure water form dams.

Pupils are told that the demonstration of the principle, done the previous day and left overnight, has not worked. It was not brought forward for all to see, neither did the teacher speculate nor engage pupils in speculation of what might have caused the failure. No attempt is made at setting the same experiment again.

- 08:07** Teacher turns to the board and continues notes on sedimentation. Pupils copy them into their note-books.

- 08:14** Teacher pauses and poses a question to pupils:

"Since the water obtained through filtration and sedimentation is *clear*, does it mean that it is safe to drink? For instance, the *clear* water from streams, is it safe to drink?"

Pupils (in chorus): "No!"

Teacher: "Why, Kgomotso."

Kgomotso: "It contains micro-organisms."

Teacher: "Can these micro-organisms pass through filter paper?"

Pupils (in chorus): "Yes!"

Comment: a) The water (filtrate) obtained in class experiments through the filtration of water and sand mixture is never 'clear', as is the water from streams which more often than not is but translucent.

Teacher observes (possibly from his experience) that pupils would still drink water from streams, or stagnant water in dams and ponds, without sterilising it despite their knowledge of the health risks entailed.

08:20 Teacher: "How can we kill the micro-organisms?"

Pupils' give somewhat appropriate answers: boil water for 15 minutes, use sodium carbonate, use chlorine!

08:27 Teacher gives pupils an 'assignment' to enquire about the sterilisation liquid used at home. Pupils quickly figured it to be Milton. There is no discussion with respect to what makes it a sterilising fluid.

Comment: As pupils had learnt some or even much of the information in their first year, it was probable that the teacher had difficulty in preparing for this class. Hence, it appeared to be a revision session lacking in clear focus and intent.

08:30 The teacher remembers that he gave pupils an assignment sometime back. He decides to check for it, randomly, while pupils are still transcribing notes from the board.

08:34 Teacher suddenly takes the opportunity to talk about soft and hard water. Pupils are given an 'impromptu' assignment on ways of making soft and hard water "pure". "Pure" is defined as making water free of any solutes.

Teacher takes approximately 2 minutes making distinctions between soft and hard water. Pupils seemed to listen attentively.

08:38 Teacher gives pupils an assignment:

"Design an experiment that will help you get pure water from hard water."

Comment: I am not sure if the experiment was to be for softening hard water and not making it "pure".

08:40 Bell rings (marks end of teaching session) while teacher instructs pupils on the format to be adopted which had to include: title, aim, apparatus - either in drawing or listed, method and results.

Pupils were told that the assignment could be their ticket of entry into the next lesson.

5.2.0 Inventory of Primary Sources of Data

The inventory shown below is presented for purposes of identifying the material from which data was drawn for analysis. The inventory has three categories: researcher-developed materials, documents and teacher-related materials.

A. Researcher-developed materials:

- 54 unstructured and completed classroom observation sheets;
- 15 completed semi-structured instruments;
- 18 unstructured and audio-taped 30-45 minute interviews;
- 20 hand-written accounts of some discussions and interviews;
- Field notes, elaborate reflections on methodology and study.

B. Documents:

i) Official documents from the Ministry of Education and available in schools:

- Integrated science syllabus document;
- Curriculum Blue-Print for the 10-year Basic Education programme;
- Junior Certificate Examination Assessment Procedures for science;
- Model Junior Certificate Examination: Paper 1 and 2;

ii) Official documents collected from the Ministry of Education after fieldwork:

- Junior Certificate Examination: Science, Paper 1 and 2 (for November 1998);
- 1999 Junior Secondary and Senior Secondary Prescription list of books;
- Floor plan for science laboratories;
- School enrolment figures for the 1996 to 1998 school years;
- Tender documents for the supply of laboratory equipment to the Ministry of Education;

iii) Official correspondence collected from schools

1. Savingrams:

- X/EC/1/9 (60), dated 29/01/97. Re: Mixed Ability Teaching Workshop;
- Unreferenced, dated 11/10/96. Re: Science Cluster Workshop for 18/10/96;
- Unreferenced, dated 31/10/96. Re: Science Cluster Workshop for 11/11/96; and
- X/EC/1/3/4/4 (1), dated 11/02/97. Re: Suggested Teaching Materials.

2. Other correspondence:

- Permission from the Ministry of Education to work in schools as per my request;
- Progress report sent to the supervisor in York

C. Teaching-related materials

- Sample time-tables of teachers;
- Test papers collected - none sat in my presence at a particular school;
- Pupil group activity (photocopies) on First Aid;
- Personal copies, six in total, of science textbooks used variously in schools. They are:
 - Science to 14 by Pople (1995),
 - Boleswa Integrated Science Books 1 and 2, Ministry of Education, 1978 and 1979 respectively,
 - Book 1 and 2 of Science by Investigation in Botswana published in 1991 by the Ministry of Education and,
 - Chalebgwa *et al.*'s (1996) New Three Year J. C. Science Revision Notes.

The inventory is important as it enumerates materials from which data was drawn for purposes of triangulation both in data collection and analysis. Also, the case study methodology relies on multiple sources of evidence for enhancing the validity of research outcomes. Items in the inventory will be referred to during the course of data analysis and in the subsequent discussion of the research findings.

APPENDIX 6

DATA CODING SCHEME

The coding scheme presented here was developed during the course of data analysis. Data was drawn nearly exclusively from observation sheets, with semi-structured interviews supplying explanations for the events. Acknowledgement of schemes referred to in developing some categories has been made in Chapter 4 for Data Analysis and Procedures.

1. Assignments :-

ASS1 - Reading assignment given as preparation of the next lesson

ASS2 - Teacher uses reading assignment as a basis and launch pad for instruction

ASS3 - Drawing given, or was evidently given, as assignment in preparation of next lesson

ASS4 - Pupils to design an experimental set up

2. Class Notes :-

CN1 - Covers material done in class - notes interspersed with teaching

CN2 - Covers material done in class as an activity on its own - isolated

CN3 - Used as a vehicle for introducing concepts not yet covered

CN4 - Continuation of notes started in previous teaching sessions

CN5 - Teacher writes notes, pupils idle

CN6 - Teacher instructs pupils to leave spaces for diagrams to be inserted later.

CN7 - Pupils write no notes during lesson

CN8 - Pupils to continue writing notes after school

3. Modes of Representation :-

MR1 - Pupils first hand experiences

MR2 - Real life or actual object from pupils' environs e.g. flower, eye, etc.

MR3 - Real life example from Botswana context in general

MR4 - Real life but a foreign example (seemingly unknown to pupils)

MR5 - Models e.g. heart, eye, etc.

MR6 - Real instrument/scientific apparatus

4. Pupil-Teacher Response Patterns

4(a) Pupil's responses to teacher's questions

PRT1 - Give answer from own repertoire of knowledge

PRT2 - Give own examples from experiences

PRT3 - Give own examples from immediate environment

PRT4 - Gives answers from textbook

PRT5 - Expresses him/herself in vernacular language

PRT6 - Pupil give an unanticipated experience-based response

4(b) Teacher response to pupils' answers

TR1 - Accepts pupil's answers /ideas

TR2 - Reacts to maintain cognitive level of participation - e.g. invites pupils to clarify or give information at same or lower level

TR3 - Reacts by extending cognitive level of participation - e.g. requesting further information

TR4 - Reacts by terminating level of participation - e.g. asking new but unrelated questions or turning attention to something else

TR5 - Rejects pupil's answer/ideas

TR6 - Rejects a pupil's answer and gives his/her own response

TR7 - Ignores pupil's answer

TR8 - First hand experiences of pupils are problematic to teacher

5. Source of Student Direction

SSD1 - Directions (instructions) for activity are given primarily by teacher

SSD2 - Directions are from pupils' materials (textbook, worksheet)

SSD3 - Directions are formulated by the students themselves

SSD4 - Pupils are given teacher-led observations

SSD5 - Pupils are directed/assisted in making specific observations and answers

SSD6 - Knowledge application - pupil identifies or applies a fact, concept, classification in a new context

SSD7 - Knowledge from previous modules

SSD8 - Knowledge in notes/textbook

SSD9 - Limited feedback - in pupils correction of own work - but no attempt is made to attend to pupil's problems

SSD10 - Pupils correct their own work - feedback is provided promptly and to a degree that appears to satisfy a substantial proportion of pupils needs.

6 Source of Teacher Direction :-

STD1 - Textbooks for the past curriculum

STD2 - Textbook "designed/based" on the current curriculum

STD3 - Textbooks for science in general

STD4 - Syllabus - abrupt transition from one topic to another

STD5 - Unplanned opportunities in lesson (e.g., failed experiments, pupils' experiences)

7. Content of Teacher's Talk

CCT1 - Misinforms pupils

CCT2 - Propagates misconception

CCT3 - Attempts to relate concepts to everyday experience

CCT4 - Utilises knowledge covered in other modules - Knowledge integration

CCT5 - Fails to link facts, observation with real life situations

CCT6 - Evidence of teacher's insensitivity to language

CCT7 - Teachers low subject matter knowledge apparent

With the large number of lesson observation sheets, all the above categories were necessary. They were useful for purposes of identifying both popular and neglected areas in teaching. However, the presentation of findings sought to give a coherent picture highlighting both the highs and lows in the data. One other thing is that the categories are very basic, descriptive and devoid of jargon which could render them unintelligible and thus making data coding difficult. The short codes were handy for marking identified pieces of data for a particular category.

c) Specific notes for activities in b) above

D. Students Daily Experiences, Examples and Contributions in Class.

Teacher :

- i) encouraged students to give their own examples
- ii) Provided time to discuss day-to-day applications of a concept
- iii) encouraged the use of indigenous materials as resources
- iv) emphasises societal applications of knowledge
- v) encourages pupils to question and challenge assumptions
- vi) encourages students to critique their experiences
- vii) helped students develop their own views and value positions
- viii) Others:

E. Illustrations in Class which are Botswana Specific:

Context in which the examples were used is to be outlined adequately.

F. Use of Textbooks in Class

a) Title and author of the text

b) Purpose of using text:

- to preview the lesson
- to introduce new concepts, terminology etc.
- to reinforce the lesson
- to summarise a lesson
- to have students to learn information independently
- to refer to instructions/procedure of experiment
- to work on questions in the text
- to assess how well students are able to read the textbook
- Others:

c) How were activities in b) above assigned?

d) When were the activities assigned?

e) Other observations.

G. Spiral Nature of the Curriculum

Concept mapping

- i) Concept taught

- ii) Prior knowledge/concepts used and their integration in concept development.

- iii) New concepts introduced in the lesson

- iv) Provision(s) for future conceptual developments

- vi) Organisational aspects of concept development and mapping

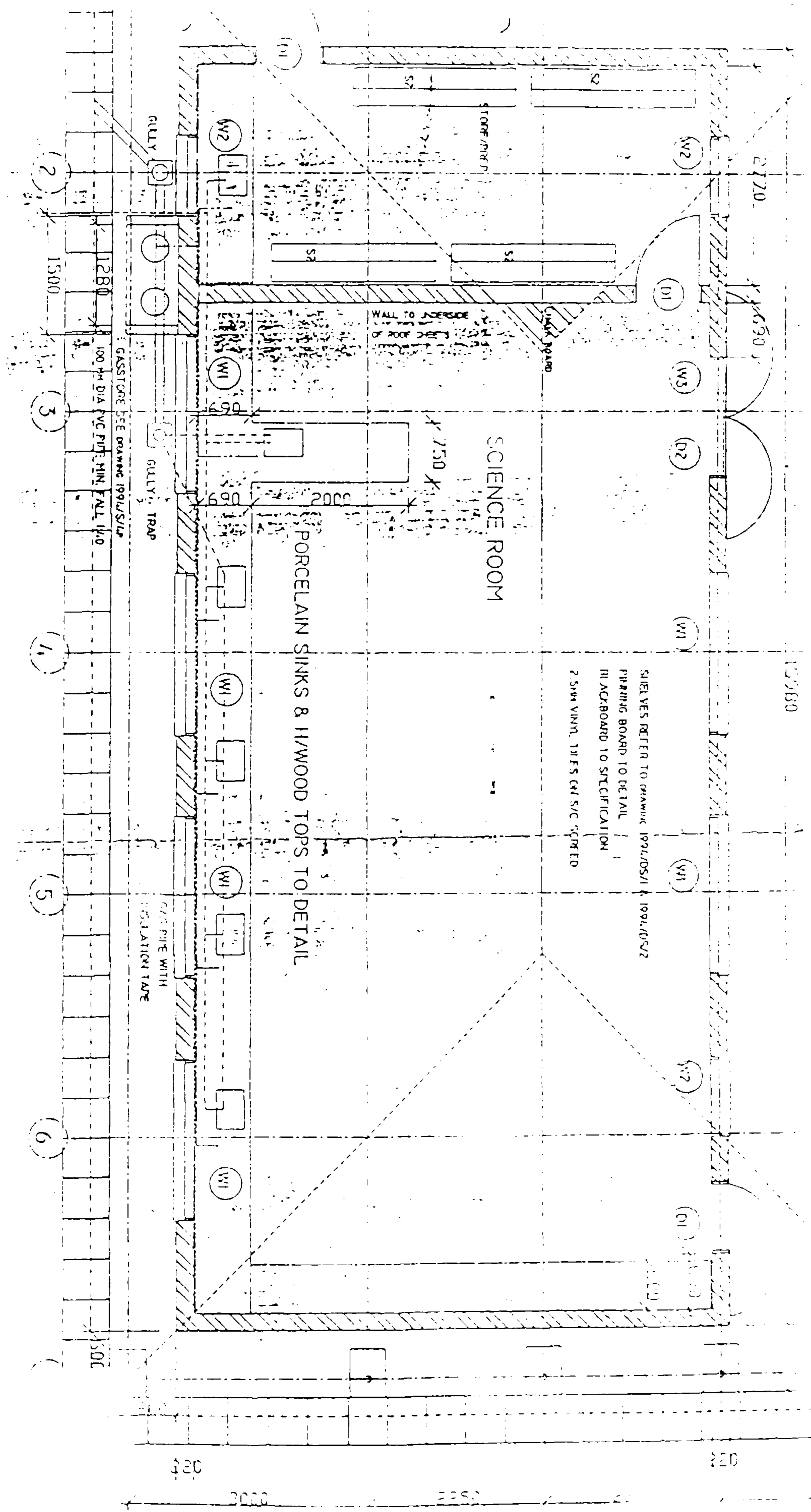
H. Lesson Profile and Summaries

Data in this section includes atypical instances; significant events; classroom activities and overview of what transpired in class in 15-minute-blocked intervals - i.e., 0-15 min, 15-30 min, 30-45 min etc.

APPENDIX 8

LAYOUT OF THE LABORATORY

This Appendix displays the layout of laboratories which were used as the main venues for science teaching. Teachers have variously referred to problems that the spatial arrangement of furniture caused them. The workbenches are located on one side of the laboratory. With whole class teaching strategies, overcrowding of pupils at the benches was inevitable. The drawing gives a visual impression of the situation.



Acknowledgement.

The layout was copied from architectural drawing No. 1994/S/1P supplied by the Boipelego Education Unit (Ministry of Education). The architect is KMM ARCHITECTS, Private Bag BR 38, Gaborone.

APPENDIX 9

TEACHERS' CONCEPTUAL DIFFICULTIES

It became apparent during the fieldwork that teachers experienced some conceptual difficulties with science content. The scale of the problem, however, could not be documented as it is beyond the scope of the work. The conceptual difficulties possibly restricted the flexibility of teachers in handling classroom transactions. Below are some examples.

Example 1

In a set of instructions in a practical activity to classify items as either solute or solvent, a teacher wrote: "dissolve sand in water and filter ..." The teacher, as did the pupils, had not taken notice of that contradiction that if the sand indeed dissolved in water, then filtering would be inappropriate. That fact was later confirmed by the experiment. But still no one queried that the sand had not dissolved.

Example 2

In a different school, one teacher said digestion of food was confined only to the stomach. Mechanical and chemical breakdown in the mouth by teeth and salivary amylase, respectively, were effectively removed from the process of digestion despite the fact that some pupils indicated this to the teacher. Insofar as digestion and the digestive system were considered in that lesson, the mouth and its associated activities were not part of it. The following is a transaction from another school:

Pupil A: Saliva softens food.

Teacher (disagrees): If you have a bicycle and you want to loosen a nut, what do you do?

Pupil B: .. Pour some oil onto it.

Teacher: Why?

Pupil B: .. to lubricate it and make it easy to move.

Teacher: Yes, lubrication. Saliva lubricates the food so that it can easily pass through the gullet ... Imagine if you eat dried bread, it will scratch the gullet, if not lubricated.

[Pon, Observation, File 14]

This was the second teacher failing on Digestion. The transaction is a **EXAMPLE 3** of conceptual difficulties noted in teaching.

Example 4

In one instance, the teacher asked her pupils: "How many substances can dissolve in paraffin?" Pupils attempted to list these, though they were wide-ranging and inexhaustible. In being given some examples, the teacher confessed to her limited knowledge of solutes that paraffin could dissolve. This clearly indicated that the activity had rested on false premises that the solutes were finite in number. Another teacher found himself in a similar dilemma in a lesson on ecosystem after he had asked pupils: "How many grasses can an antelope feed on?" Pupils made wild guesses: "3000 4000 etc. grasses!". The teacher never gave them his answer or rather, explained what the question wanted.

Example 5

The following four instances are examples of cases in which pupils were exposed to wrong or incomplete information of various sorts.

1. Teacher (during group presentations) states that: "they (i.e., a group of students) were looking at the chameleon as an animal ... A chameleon cannot run when it sees its enemy and therefore changes colour for camouflage". [Obo, Observation, File 1]

2. One pupil said that hail is formed through a process of sublimation. This was written in teacher-made notes. The teacher accepted the response. [Pon, Observation, File 6]

3.

Teacher: Why did temperature increase during heating?

Pupil: The temperature increased as the time went on because more heat is added.

Teacher: Yes, That is the correct answer!
[The teacher repeated the answer almost verbatim, repeating the notion that heat is added]

Teacher: The extra heat added after the water began to boil is used to change water from liquid to vapour.

[Dus, Observation, File 6]

4. A lever pan balance is introduced to Form 1 pupils as a "triple arm balance". The triple arm referring to, according to teacher, the shape/pattern of the base of the balance. [Mru, Observation, File 1]

APPENDIX 10

SCIENCE TEXTBOOKS

The purpose of this Appendix is to provide information on science textbooks that were used in the implementation of the curriculum. The information is in two sections. The first section gives a brief history of the textbooks. The second looks into their frequency of use in general and by classroom activities.

10.1.0 Background Information on Textbooks

Boleswa Integrated Science Books 1 and 2 were core texts of the pre-1986 curriculum. They are derivatives of the texts for the Scottish Integrated Science Scheme. They were each available during the study (i.e., fieldwork) in relatively small numbers, but enough in older schools for a class of 40, and less so in those opened in or about 1991. The texts, first published in 1978 and last in 1991 (Ministry of Education, 1991a, p. ii), were part of a common science curricula used in the 'BOLESWA' countries which are Botswana, Lesotho, and Swaziland. Following major educational reforms in Botswana in 1986, the alliance between the three countries collapsed. The Ministry of Education in Botswana published two science texts in 1991. They were entitled *Science By Investigation in Botswana: Pupil's Book 1 and 2*. The two were for the two-year science curriculum used in the junior secondary schools starting in January 1986 until December 1995. The texts were by far used widely across all the schools in the study.

Chalebgwa *et al.*'s textbook, entitled *New Three Year J.C. Science: Revision Notes*, whose publication and release coincided with the introduction into schools of the new curriculum, were also pervasive across schools. The arrangement of the chapters in the book followed that of modules in the syllabus. The book also has "over 400 multiple choice questions and answers and over 100 structured and practical questions" (Chalebgwa *et al.*, 1996). At least three other books which were specifically developed for the syllabus by various authors never made it to the classrooms. One set of books, modelled along the same line as *Science by Investigation in Botswana*, failed on account of plagiarism and violation of copyright allegations.

The third category of books includes those which were developed for contexts and syllabi other than that in Botswana. Two of the books, one by Pople (1995) *Science to 14: KS 3 Summary Book*, and the other by Tom Duncan's (1979) *Physics for Today and Tomorrow* were each found separately in two schools in copies of about 30-40. On the other hand, Roberts (1988) *GCSE Biology* text, Beckett (1984) and Mackean (1984) were used variously by teachers and almost negligibly in class during the fieldwork.

Of all the books, the Ministry of Education's (1998b) book prescription lists for the 1999 school-year identified Books 1 and 2 of *Science by Investigation in Botswana* as 'core texts' (p. 38), while Chalebgwa *et al.*'s together with Pople's texts, were referred to as "library texts" (ibid.). A core text is defined as "text book(s) to be used by all students" (p. i), though schools have a choice where multiple texts are prescribed and, "funds permitting, it is expected that all students should have at least a copy of one of the texts in this category" (ibid.). At the other extreme, texts prescribed for the library are meant to give "teachers an idea of what texts exist in their subjects so they could recommend them for purchase to the librarian" (ibid.). This appeared to be incongruent with the observation that Chalebgwa *et al.*'s textbook was widely available and used across schools. It should be noted that the books belong to schools and are loaned to pupils either on a short- or long-term basis. Ideally, core textbooks are provided in numbers to allow each pupils to have a copy for the entire duration of their study in a particular school.

10.2.0 Use of Textbooks

The use of textbooks is seen in regard to class level (i.e., Form) and activity. By comparison (see Tables A10.1 and A10.2), *Science by Investigation in Botswana* texts were used much more extensively in classrooms than any other text. The two were often used together. This view is supported by the number of instances of use recorded for each book, possibly confirming that teachers scouted for information in both of them during teaching. The frequencies also show that they were primary texts used with the curriculum. Moreover, they were the most abundant in schools and therefore readily available in numbers allowing each pupil access to them. However, Books 1 and 2 of *Boleswa Integrated Science* were used infrequently, possibly due to their scarcity in some schools in general. Also and most importantly, *Science by Investigation in Botswana* are modified versions of the former. As shown in Chapter 8, the In-service Officer of the region recommended the Boleswa texts for use as *ad hoc* Teachers Guides, possibly indicating that the new curriculum had, at the time, no customised recommended textbooks.

However, both Tables A10.1 and A10.2 showed that Tom Duncan's *Physics for Today and Tomorrow*; Pople's *Science to 14* and Beckett's *Biology for Life* were each used only once in class by pupils. Exceptions to this observation was Pople's *Science to 14*, which one school had acquired about 60 copies for the new science curriculum. Tom Duncan's text whose 40 copies were available in one school, together with about 20 copies of Beckett's *Biology for Life*, were used in different schools for both reading assignments and in concept development. The frequency of use of the three books was minimal as shown in the table.

Text	Form 1	Form 2	Form 3	Totals
Revision notes for JC	5	5	2	12
Boleswa 1	0	1	0	1
Boleswa 2	0	5	3	8
Science by Invest. 1	4	14	2	20
Science by Invest. 2	4	13	1	18
Physics for Today ..	0	0	1	1
Science to 14	0	2	0	2
Biology For Life	0	1	0	1
Total by Year + (%)	13 (21)	41 (65)	9 (14)	63

Table A10.1 Textbook Use by Form

Notes:

1. The Table reflects instances when teachers overtly referred pupils to specific sections of a given text;
2. The Tables do not include instances in which textbooks were used covertly by teachers. Such instances were identified by researcher through referral to books.
3. Full titles of books appear at the beginning of the Appendix.

Table A10.1 on the use of textbooks by form, shows that textbooks were used twice as much more at Form 2 than at Form 1 and 3. In looking at the syllabus, the specific objectives of modules, covered during the study, and in Form 1, tended to encourage teacher-talk. Also, though two cohort groups of Form 1s were observed, the other group was of new recruits in January 1998 who were being introduced to learning science at CJSS level. This means that almost all the observations for Form 1 were done in Phase 1 of the study with the cohort group that was at the end of their year at Form 1.

Second, unlike with new Form 1s and 3s in Phase 2 of the study, some teachers retained and moved on with their Form 1 classes to Form 2, which resulted in possible continuation of traditions established previously. This was not the case with new recruits and with some Form 3s who, being the first cohorts at that level, meant the schools were operating at full capacity for the first time and considerable adjustments had to be made to allocations of teachers.

On the other hand, all three new schools, which were opened in 1996, were delayed in completing the previous year's syllabus and taught the last sections of the Form 2 syllabus to Form 3s. This involved about nine teachers and about seven Form 3 classes. The classroom observations were recorded as Form 2 and not Form 3 activities.

Text	Experiment	Class Notes	Class Exercise	Read. Ass.	Conc. Dev.
Revision. Notes	1	1	2	6	2
Boleswa 1	0	0	0	1	0
Boleswa 2	0	1	2	2	3
Scienc by Invest. 1	3	3	4	6	4
Science by Invest. 2	1	3	3	7	4
Physics for Today ...	0	0	0	1	0
Science to 14	0	0	0	1	1
Biology For Life	0	0	0	0	1
Totals + (%)	5 (8)	8 (13)	11 (17)	24 (38)	15 (24)

Table A10.2: Text Use by Activity

Notes:

1. Read. Ass. stands for Reading Assignment;
2. Conc. Dev. Stands for Concept Developmnet.

Table A10.2 shows that textbooks were used relatively widely for reading assignments which tends to lend credence to observations on the nature of assignments (see Chapter 5). However, the textbooks were used relatively sparingly in experiments. And, the entries in Tables might be misleading as the information on how long each episode of use of textbook lasted, is missing. The most important point emerging from the Tables is evidence that textbooks pervaded almost every aspect of classroom life. This is important in view of the weaknesses already noted in the textbooks though they appeared to be a major source of guidance and direction of teachers in the implementation of the curriculum. With such a diversity of textbooks, it appears clear as to why the philosophy on which the curriculum was founded did not come out clearly in teaching.

However, there seemed to be no clear cut procedures and guidance for acquisition of the textbooks. While teachers in some schools had ordered textbooks of their choice, others had not. The following interview elucidates the point:

Researcher: ... you said you use different texts, can't you recommend them for classroom use?

Respondent: ... sometimes we try to recommend but they say recommendations should be made by the Ministry of Education.

Researcher: Who said that?

Respondent: The school Head ... like for instance, if those people who sell books come to the school to display their books, then we recommend one, the School Head will say an order cannot be placed until a recommendation comes from the Ministry of Education.

(Mas, Interview, File 13)

In contrast, a teacher in a different school which had purchased Pople's *Science to 14* was gratified with his choice:

With 'Science to 14' textbook, the language there is at their level. It is easy to use, they can understand it. Also, it is written in 'spreads' and these are very short; they cover only two pages for a topic, therefore it is easy for them to understand; at the same time, at the end of the 'spread' there are revision questions so pupils are always encouraged to try them.

(Rak, Interview, File 7)

There were clearly some problems with procurement of the texts which, in turn, perhaps affected the morale and confidence of teachers particularly of those who had to do without the books of their choice. In terms of implementation of the curriculum, the inconsistency meant that some teachers were possibly in a facilitative environment, while elsewhere, the environment was constraining: a possible indicator of communication break down between the Ministry of Education and science teachers. Incidentally, none of the teachers had mentioned a book-list of texts officially prescribed by the Ministry. The copy which I got from the Ministry of Education was for the 1999 school year. As explained in earlier, Chalebgwa *et al.*'s textbook is featured in the list as a 'library' reference with *Science by Investigation in Botswana* books being 'core' textbooks. It is not clear if the same was true for the period 1996-1998, which was the first phase of the five-year phased in implementation of all the subjects in the school curriculum.

APPENDIX 11

REVIEW OF METHODOLOGY

This Appendix reflects the *findings* of research in light of methodology adopted in the study. The *findings* in this case should be seen in terms of experiences, insights, and reflections on the whole process of undertaking the fieldwork. The *findings* are thus different from analytic and conceptual findings or substantive conclusions on the implementation of the curriculum. A retrospective outlook on fieldwork experience is made necessary by two key factors. First, the substantive conclusions of the study cannot be understood outside the very context or research processes which were adopted in data collection. Secondly, participants reckoned to be trapped in a "stressed" and unsupportive environment. This had a bearing both on the research findings and on the conduct of fieldwork.

Also, fieldwork itself generates various types of experiences which might expose certain strengths and limitations of the research methodology adopted. This contextualises the data and findings and helps bring to the surface issues that might impinge on its reliability and validity (cf. Nunan, 1996). Part of the focus of this chapter is, therefore, to show how adaptations were made in the field but this would not take the form of a "heroic tale in which the diligence, cleverness and artifice of the researcher is very much to the fore" (cf. Troyna, 1994, p. 5). Instead, I would be acknowledging an educative aspect and influence of the research and that I emerged wiser from the field work and given a chance, things would be done differently. A *reflective* style of writing is adopted such that any influences that the researcher encountered, or might have encountered, in the data collection are revealed and explored in context. This is consistent with the view adopted in this work that participant observation is reflexive. A section on reflexivity covers any other aspects which could not be integrated in other parts of the work.

The chapter deals with aspects of data collection; interviews as an exemplar of access negotiation; self-reflexivity and generalisability of research outcomes. The discussions are linked to the existing literature on qualitative methods. An evaluative overview of the entire research process concludes the chapter.

11.1.0 Data Collection

Collection of data in the field occurred in two phases of 14 weeks each. Phase 1 was in September-December 1997, and after a six-week break, came Phase 2 starting in January-April, 1998. The two phases are part of a continuum but are discussed separately. Discussions generally emphasise how validity and reliability of data was promoted during data collection. The discussion concludes with a brief overview of how factors integral to schools impinged on the conduct of the study particularly in Phase 2.

11.1.1 Data collection in Phase 1

Decisions were made randomly regarding which particular school to work in during a one to two week(s) block of data-collection and the choice of classes to be observed. Each school was given a week's notice in advance of my visit. The observation scheme within schools was decided on independently and based on teachers' time-tables. This ensured that teachers did not selectively pick what they considered their best or favourite classes. The 'randomisation' (see Miles and Huberman, 1984, p. 232) enhanced 'self-verification' of data. With hindsight, and based on the general tone of dissatisfaction by teachers regarding their pupils, the random selection of classes appeared prudent. For instance, as one teacher said during interviews:

... you will realise that these Form 1s, the type of students in this class - I have seen their grades - most of them are better. With the Form 2s, the majority are weak - but the interest the Form 1s have in my lessons, keep the 'momentum' going.

(Pon, Interview, File 6)

Each teacher was observed working with one particular group of pupils (class) for a total of six periods (i.e., 6 x 40 minutes blocks) which were taken in pairs to constitute three lessons on different days of a week. If there were three teachers in a school, the possible maximum periods observed in a week was 18. Each teacher was observed only once in any given day for purposes of avoiding unduly patronising them. This also meant spreading of observations such that they would not all fall on a good or bad day for the particular teacher. Also, I made a maximum of three observations (three lessons, i.e., six periods) on a busy day. This was because the observation exercise was strenuous. A time to reflect on observations, to have a break and meet other teachers in the staff-room was needed as part of the methodology requirements.

Observing three lessons for one class in a row has a number of advantages for data collection. For instance, a) instances of repetition of lessons could be easily spotted; b) it allowed following continuity in concept development with respect to content, variation of activities, approach/methodology of teaching; c) it enhanced reliability in recordings as making observations on a teacher for the first time did not allow a chance to verify some observational data. Also, settling in to a class through repeated and prolonged contact with a teacher and one class generated conditions conducive to data collection. It also helped provide a sense for the direction in which lessons were going. This seemed to draw some validation from and seemed to be consistent with the way teachers planned their teaching. For instance, in one case in which when I told the teacher that I would observe him again teaching the same group of pupils, the teacher stated emphatically, that:

... I am trying to lead the class somewhere ...

(Dus, Conversation, File 6)

This pointed to two issues. First, that teaching sessions for any one class were highly likely to be inter-related and should not be considered in isolation. Secondly, there might have been some form of psychological gain to some teachers such as those who might have felt they fared badly in one lesson, so needed another chance to make this up in their own way. But overall, the profile of teaching, comprising key issues, recurrent events and activities (or chain-of-evidence) resulting from prolonged contact was itself a good basis for developing interview questions firmly grounded on multiple observations.

What was important here was that the procedure resulted in a 'case' of reasonable 'internal validity' for a particular teacher. As Hurwitz (1979) indicated, comparing recordings of the same class over a period of several days helped ratify the stability across lessons of classroom behaviour purported to be measured or recorded during observation. Applying a similar strategy of recording across all participants helped to ensure that recorded observations collectively comprised a reliable data source in the study. The internal validity of case studies and qualitative studies in general have been seen to be very crucial, reflecting in-depth understanding of a given phenomena or area of study (Vulliamy, 1990d and 1990e; Anderson and Arsenault, 1998; Yin, 1984; Lincoln and Guba, 1985).

The in-built analysis of data during this phase led to the identification of a number of themes. This had implications for data collection and for on-site data validation procedures through the use of books and pupils as additional data sources. I had to buy copies of the four key textbooks and searched for the other two from my archives. I referred to these during teaching observations. That helped me particularly in cases where pupils were given tasks in the textbook as well as in verifying *in-situ* the use of the textbook in teaching which manifest in teaching in several ways. For instance, presentation of concepts by teachers; notes copied verbatim onto the board; selection of pupil activities and, instruction to pupils were taken from textbooks. There were instances in which pupils' responses to questions from teachers showed that they knew, or, were rather, familiar with, the subject matter. In such cases, a copy of the syllabus offered a quick reference to check whether the topic had been covered previously. Instances of repeating lessons were unearthed through this technique as well as by checking pupils' note-books.

Occasional interaction with pupils also provided some useful information. For instance, during class practicals I seized the opportunity to visit different groups of pupils and held short conversations with them in a manner that did not distract the attention of the class from a given activity. Such instances include the case of pupils who said that a metal cube, with length of approximately 20 millimetres per side, is heavy. They could not explain to the researcher their answer which was chosen from the alternatives given on the board. Another case is that in which

pupils had been directed to answers in an activity on categorising rocks as igneous, metamorphic or sedimentary. The following dialogue is incisive:

Researcher: What type of rock is this?

Pupil: .. it is a metamorphic rock.

Researcher: Why?

Pupil : ... because the teacher told us so!

(Mol, Conversation with pupil, File 3)

The dialogues were short particularly because permission to hold them was never sought from teachers. Looking through pupils' notebooks raised some ethical issues concerning pupils' right to privacy (see Anderson and Arsenault, 1998). For instance, it became apparent in some cases that some pupils sometimes left classroom tasks incomplete (e.g., diagrams, questions). Further evidence suggested that some note-books were never collected for correction. In paging through notebooks of new Form 1s in January 1998, it also became apparent that one teacher had been insensitive to the pupils' (age 13+) level of language development. The following statements appeared in the notes:

Explanatory note ... Hypothesising is to have an intelligent guess or prediction of what will happen ... Experimenting, testing whether something is true or not. After testing, the experimenter can reject or modify the hypothesis Inferring: a conclusion.

(Rak, Pupil's notebook, File 1)

There were other incidents in which pupils stated that the lesson or activity was a repeat. For instance, one teacher gave pupils a task of drawing a diagram of a mammalian heart. Pupils explained that they had drawn it in a previous lesson. If it were not for the pupils, I would not have known that the lesson was a repeat.

However, pupils were not made active participants in the study for two key reasons. First, involving them would have meant that my presence both in class and school would have become more and more obtrusive, contrary to the ideals of my position as a participant observer. Second, the time-frame for the study was too short to permit establishing trust and rapport with an expanded group of participants. It would also have raised some ethical (see Bogdan and Biklen, 1992) and methodological concerns, particularly analysing data from two groups who naturally would interpret phenomena in classroom from different perspectives. Brown and McIntyre (1995) and Cooper and McIntyre (1994) elaborately capture the methodological difficulties of, first, working with pupils and, second, searching for a common ground between their perspectives and those held by teachers. Overall, my activities as explained above show how data was collected and validated, where appropriate, on site. This continued in Phase 2 of data collection.

11.1.2 Data collection in Phase 2

There are two key features which distinguished data collection in Phase 1 from that in Phase 2. First, while a total of six lessons per teacher was still observed, they now involved three different classes: i.e., Form 1, Form 2 as well as Form 3. The Form 3 classes were the first of the 3-year curriculum. In terms of methodology, this meant seeing the implementation of curriculum by one teacher across a cross-section of classes, implying a strong possibility of corroborating patterns previously identified in teaching. Phase 2 thus seemed to play a validation or confirmatory role particularly that the six-week school vacation that preceded it was a significant break to disengage teachers and myself from the tempo, routines and traditions of teaching in Phase 1 (cf. Goetz and LeCompte, 1984, p. 88). With the arrival of new Form 1s from primary school in the first school term in 1998, an opportunity was created to see how the culture of learning was developed in science classrooms and to further compare it with that displayed by the previous groups at their exit point (i.e., third term, Phase 1) of Form 1. The fact that similar routines and teaching traditions were noted with the new pupils served to confirm some significant aspects of the implementation of the curriculum.

Phase 2 also involved an element of validation, particularly that, as had been observed in chapters on research findings, conditions of learning science at primary school and CJSS were incomparable. This was evidenced by the three instances which challenged my participant observer status in the new Form 1 classes. The instances were of practicals which overwhelmed the pupils who had little or no knowledge about the apparatus, could not read instructions, or make measurements. With one teacher to at least 40 pupils, and with the observed problems, I became involved in doing the experiments, tutoring and working with the pupils on the use of the apparatus. Participant observation now had a direct experiential value (cf. Scott and Usher, 1999, p. 100). This involvement widened my modes of data collection which could not be explored in the previous phase as the pupils had become familiar with some routines in practical work.

11.1.3 Data collection and institutional factors

As stated in Chapter 1, the study was undertaken in the second half of the first phase (i.e., January 1996 to December 1998) of a five-year phased-in introduction of a Ten-Year Basic Education programme into schools. The fact that the study was conducted in two terms (i.e., term 3 corresponding to Phase 1 and term 1 corresponding to Phase 2 of the fieldwork) had been seen positively as presenting a comparative context in which validity of observations made in Phase 1 could be checked. But as it was, schools operated at full capacity (in terms of intake, streams and curriculum coverage) for the first time under the new curriculum in Phase 2. There was no corresponding increase of teachers. Teachers' workloads increased drastically such that some were engaged 75 to 86% of school time. Some Form 1 classes in 3 schools had to do without teachers. The three deputy Heads involved in teaching in Phase 1 could not relinquish their

teaching duties in order to help overcome the shortage of science teachers in their respective schools.

These factors affected the fieldwork in three key ways. First, the congested teaching time-tables for teachers meant reduced contact time between us. Second, teaching at the three levels (i.e., Form 1, 2, and 3) meant that teachers re-prioritised their activities and spent more time than previously on preparation during school time, particularly in their 'free periods'. I had to be appreciative of their difficulties and, in turn, minimised intrusion into their use of time. The trade-off here was that field relationships were under threat of being highly contractual and thus challenging my conviction and understanding of access negotiation as resting on fruitful field relationships (i.e., rapport). Third, while Phase 2 had revealed or magnified some organisational problems of implementation that they became more evident and axiomatic, they seemed to readily provide a refuge for teachers: there was a high preponderance of references to the problems in teachers' explanations of their practice. This threatened the 'progressive focusing' component of the study. The dilemma faced here was also that I could neither deny the existence of the problems nor could I be in a teacher's position. Also, teachers not only expected appreciation and understanding from me, but they expected sympathy as well. The situation thus *prohibited* exploring other possible explanations, while, on the other hand, supported others, in particular, *vindicating* teachers from blame. No matter how strongly I felt disadvantaged, the respect for research ethics and teachers' perspectives (and thus ecological validity) had to be upheld (see discussion of interviews below). However, classroom observations were relatively consistent in focus and apparently demonstrated no significant changes in practice.

Overall, a total of 69 lessons, giving a combined total of 92 hours, were observed in both phases of the study. However, there were instances in which observations could not be made due to unforeseen problems in schools. For instance, teacher absenteeism. Teachers absent for one or two days from teaching during my visits were not observed upon their return to avoid getting "distorted" data. The teaching was highly likely to be deliberately attuned to making-up for lost time. In terms of loss of opportunities for classroom observation, the gravity of the matter could be appreciated in that each individual teacher taught multiple classes which became invalid for observation due to the absence. Also, the fact that each school was given a one-week notice in advance of my visit meant limited flexibility in terms of re-scheduling observations in lieu of any unforeseen circumstances. The list below shows samples of other cases in which classroom observations could not be done. They are:

- a) Arrival of five novice teachers in January 1998 while the study was in its second phase. They were excluded from the sample as they had graduated from teaching colleges in December 1997. There also exists some documented evidence of differences in 'professional craft

knowledge' of neophytes and expert teachers (see Brown and McIntyre, 1995; Olson, 1992; Denscombe, 1980; Gonzalez and Carter, 1996);

- b) The three new schools opened in 1996 and were delayed in completing modules for Form 1 and Form 2 in the 1997 school year. As a consequence, teachers first taught the material for those years in the new school year in 1998. This involved at least nine teachers and 12 Form 3 classes. This resulted in fewer than expected cases in which Form 3 material was taught;
- c) Water shortage in the village and in school disrupted classes. According to the Radio Botswana's 7:00 a.m. News Bulletin on 9/10/97, three of the 12 boreholes supplying the village with water had been shut down: two due to sewage contamination (seepage from pit latrines into aquifers below them) and the other due to mechanical breakdown. Classes were delayed in the mornings and pupils were dismissed at 12:00 p.m. The water-shortage problem recurred early in 1999 (see Note 1);
- d) Scheduled observations and interviews were cancelled in one school because of police investigations into two forged school cheques used in the purchase of a photocopying machine in town. Teachers had to go on an identity parade and help with investigations over a two day period;
- e) Preparations for athletic competitions in Phase 2 to select a school athletic team on Friday and Saturday of the week affected school visits. Teachers were not available either for interviews or observations by Thursday as the school went into recess at tea-break;
- f) Eight Form 1 classes were without science teachers in three schools. Some teachers on transfer from other schools had apparently not turned up in time for the beginning of a new school year in January 1998. This was in Phase 2 of the fieldwork;
- g) One school held a prize giving ceremony which also doubled up as open day on a Saturday in first term in January 1998. Teachers and pupils were variously involved in preparations throughout the week;
- h) Four teachers were away on different occasions attending workshops and meetings on school administration and science teaching.

The problems cited above comprise a significant factor in the study. First, in terms of contributing to the ecological validity of data, they show variables or factors which were part of the data collection process and invariably form part of the research findings. Second, in view of the study's time-frame, the lost opportunities for observation became important in contrast, to say,

research studies with multiple phases each spanning at least a year or more (see, for instance, Vulliamy, *et al.*, 1990). The longer the study lasts, the more there tends to be a 'cancellation or averaging effect' which makes the missed opportunities relatively insignificant. Interviews with teachers are discussed next.

11.2.0 Interviews

The discussion of interviews also illustrates the fact that access negotiation was a continual process pervading all aspects of fieldwork. So, interviews were more than just opportunities for soliciting information from participants, they also entailed strategies meant to facilitate gaining access to one's professional self or intellectual repertoire on selected aspects on the implementation of the curriculum. The discussion focuses on two inter-related areas viz.: responses from teachers and some key challenges of interviews in light of data they solicited. The conduct of the semi-structured interviews has been discussed in Chapter 3.

11.2.1 Data from interviews

Teachers were generally predisposed to supply what can be termed 'factual' and 'reliable' data. 'Reliable' here qualifies 'factual' and is basically used to indicate that the data was probably indisputable and 'common knowledge' amongst teachers themselves. For instance, the data covered four broad areas viz.,

- a) high teacher-pupil ratio in six of the eight schools of one teacher to 38-45 pupils at a time;
- b) the general ability (and achievement) of pupils, generally perceived as incongruent or inarticulate with the perceived needs of the curriculum;
- c) resource constraints (e.g., proper textbooks; Teachers' Guides and in-service workshops) and,
- d) the perceived 'disinterest' of the Ministry in the implementation of the curriculum.

The data yielded in the interviews was consistent with that sought through 'formal interviews' which Furfey (1965) describes as being meant to "solicit information of a specific and overt sort - names, dates, places, conscious opinions of interviewee, and the rapid impressions of the interviewer" (p. 322).

Such data did not conclusively indicate the meaning or interpretation and decision-making of teachers in "unpacking .. the curriculum storehouse" (Hamilton, 1990, p. 42) and the underlying convictions of teachers in translating it "into a form that is accessible to learners" (*ibid.*). This is one view of teaching, and, invariably, that of curriculum implementation. The attention of the Supervisor (in York) was drawn to the above *problems* five to six weeks into the fieldwork through a 13-page progress report. The following excerpt is incisive:

... the main problem encountered during interviews is that teachers can only justify their practice in terms of problems inherent in the education system ... it has been rather difficult to get to teachers' professional self: a level where they have a standpoint and can 'theorise' about their practice without bemoaning their plight ...

(Progress report, October 1997, pp. 3-4)

With more and more teachers supplying information of similar genre', there was a challenge and a need to ease into the situation, 'bracketing perceptions' borne of the needs of the study (Wilson, 1977, p. 251; Knupfer, 1996, p. 142) and of 'reality' to be studied (Edwards and Westgate, 1994, p. 74). On the other hand, the similarity of information from independent sources seemed to challenge Bogdan and Biklen's (1992) general observation that "many subjects feel self-conscious at first, contending self-effacingly that they have nothing important to say" (p. 97). A contributing factor to my heightened awareness and perception of the challenge was, perhaps, nurtured by the desire to realise 'depth interviews', which "seek to discover the interviewees hidden motivation and unacknowledged attitudes and are often centred around emotions than conscious ideas" (Furfey, 1965, p. 323).

The dilemma faced in interviews had further ramifications. By attaching value to interview data, there were risks of 'discrediting' or 'dismissing' as 'worthless' the information given by respondents. This a problem of ethics. There was also a risk of losing data which was grounded in participants' perceptions, experiences and values germane to the context of their work environs. And, persistence in getting this or that sort of data was in itself a threat to a congenial environment and relationships established both in interviews and through classroom observations:

Depth interviewing demands methods of its own ... For one thing, the information being sought may be hidden from the consciousness of the interviewee himself and hence direct questioning will obviously be useless. Again, even if the interviewee knows the answer, a pointed question could have an opposite effect from that intended; it might put him on the defensive and destroy rapport ... The purpose is to elicit subtle attitudes and emotion rather than information, and these come to the surface more readily when the interviewee rambles on his own way ... (ibid., p. 328).

Clearly, the mode of access negotiation in the latter type of interview points to the complexity of fieldwork and of working with the participants. The 'rambling on' as a strategy for access negotiation to the 'private spheres' of knowledge or, perhaps more appropriately, 'professional craft knowledge' (Brown and McIntyre, 1995, p. 108) (see Note 2) is acknowledged in the literature on qualitative research. For instance, by Vulliamy (1990c), Anderson and Arsenault (1998), Measor (1985), and Burgess (1985). The conduct of depth interviews is discussed here with particular regard to how rambling was used as a strategy for 'access negotiation' and how it fitted in with the study.

Rambling here is taken to mean a discussion-type of response of the respondent which is prompted by a deliberate structuring and presentation of questions by the interviewer. The rambling is, therefore, purposive and thus different from a talk in which the respondent could be deemed either irrelevant, lacking in focus, or simply fumbling. Where appropriate, the strategy adopted in fieldwork was to ask two closely related questions at a time, one as a precursor to the other. For instance, a question on a teacher's understanding of the curriculum could be accompanied by another on how that understanding influenced their teaching. This seemed to place teachers in a rather reflective or evaluative mode, giving a strong potential to yielding a comprehensive, coherent and rich contextual data that would otherwise have not been solicited if the two questions were presented separately. The strategy also helped to avoid 'knowledge gaps' and thus preserved the integrity of the interviewees' perceptions of their reality. This enhanced the 'construct validity' (cf. Magoon, 1977, p. 669) or idiosyncrasy of data. This is consistent with the main perspective of the study which places emphasis on "meaning(s) constructed by actors in terms of which they interpreted the world and on the basis of which they acted in the world" (cf. Hammersley and Woods, 1976, p. 2).

One of the key challenges involved in rambling was that some interviewees' responses were long. In analysing the interview protocols, however, it became apparent that during their deliberations teachers did not lose sight of the thrust of the question. More often than not, they concluded with a statement that amounted to the core of their answers. The tape recordings of some interviews were useful for conducting in-depth interviews, as they allowed teachers to ramble on uninterruptedly. This helped to avoid three key problems associated with listening and writing interview accounts. The problems are: a) loss of data as the listening and writing would have been a selective process; b) competition for time between writing and thought processes (e.g., level of perception of researcher, identifying emerging themes and issues, developing more questions *in situ*); and, c) it was not going to be economical on time - as a comparison, the amount of data captured on one side of a 60-90 minute audio cassette generated about ten hand-written pages which took at least four hours to transcribe, verbatim.

On the other hand, written accounts of interviews were 'scribbled' as short notes filling a few pages and often required *dressing the skeleton* after interviews. Dressing the skeleton was a reflective exercise and helped in the formation of a picture or a perspective which on its own was vital for pulling the data together. The comments made proved worthwhile in the data analysis months later when in York and preparing this work. Also, the interview accounts fulfilled many other distinct research roles. Apart from reducing my "threat quotient" (Miles and Huberman, 1984), they also played a confirmatory role in which over-subscribed or saturated categories of data were identified. It gave more time for identifying negative instances and unexplored areas that needed to be followed up in subsequent classroom observations and interviews. It could be

argued that though the interview accounts were relatively weak in ecological validity, they were useful in 'progressive focusing'.

The level of simplicity in teachers' explanations was striking. The answers were simple and straight-forward which is vital to this study. There was clarity of expression uncluttered by educational rhetoric (e.g., child-centred, problem-solving) (cf. Lewin, 1990c, p. 121-122; see also Brown and McIntyre, 1995, p. 17) or "educationist context" which "draws selectively and consciously on educational theory and research" (Keddie, 1971 cited by Hargreaves, 1981, p. 303). The teachers' perspectives were thus framed in a

... highly pragmatic world; the world is rather than ought; deeds not words; practice not theory. It was (therefore) a world that was fundamentally organised around principles of habitual and pragmatically-based common-sense thought and action (Hargreaves, 1981, p. 303).

This firmly locates and describes the position of teachers' perspectives in the study. It could be taken to be further evidence of the context in which teachers operated. Teachers' concerns were with the practicalities of the curriculum and they had probably not yet moved to questioning its' philosophical or theoretical ideals. However, two key difficulties arose during the interview. First, access negotiations into areas of teaching where teachers appeared to have problems; second, reaching out to the aspects of teacher practice.

11.2.2 Key challenges in interviews

Though teachers admitted some difficulties with the curriculum, it remained challenging to discuss the specific difficulties that were observed during the course of teaching. This had been noted early in the fieldwork and duly noted in the progress report to the supervisor:

... the fact that teachers sometimes commit mistakes (e.g., misinforming students) too evident (to be ignored) ... has meant that interviewing them has become a sensitive exercise. I therefore avoid asking questions likely to lead to conflicts as well as undermining an individual's confidence and integrity. I believe this denies me information which might otherwise complete a picture about aspects of classroom practice.

(Progress report, October 1997, p. 5).

However, none of the teachers queried their pre-service training from colleges. This becomes a significant factor in considering their (i.e., teachers') perspectives as the colleges were developed specifically to produce teachers to work in a CJSS environment.

Another challenge faced in interviews was validating my viewpoints developed during observations and evident in lesson profiles through presenting them to teachers for comment. This was another possible dimension of triangulation in the study (see Hitchcock and Hughes, 1992; Brown and McIntyre, 1995). It seemed teachers were intimidated by the approach and became

defensive in their responses. Several reasons can be posited to explain the behaviour. One is that the symmetrical power relationships between me and them, arising particularly from the fact that some seemed to see me as an expert on science education, it appears, made it difficult for teachers to respond to what might have seemed a challenge to their practice. More profoundly, and borrowing Chatwin *et al.*'s (1994) expression, the strategy was possibly construed as "the initiation of a micro-political activity which may be seen as threatening for those concerned" (p. 70). The other reason had to do with the fact that teachers' concerns about practice constraints were possibly indicative of their "desire to be evaluated positively" (cf. Wilson, 1977, p. 248) particularly as shown in the research findings that some teachers expressed self-doubts and reduced self-esteem. The difficulties expressed tended to go against the principle of triangulation in which 'alternate interpretations' (Knupfer, 1996) are checked for validity and 'close-correspondence with reality' by teachers themselves. The overall impact on the study was that teachers' reactions to my viewpoints could not be used as data sources or input to the data analysis and subsequent reports (cf. Fraser *et al.*, 1992, p. 62). This leads to a reflective and retrospective overview of interviews as one of the key sources of data in the study.

Overall, data from interviews suggested the existence of widespread problems with the management of the curriculum and with its implementation. This was evidenced by the high preponderance of teachers' perspectives focused on the problems. In retrospect, questions could be asked if interviews were the 'best' mode of soliciting data in light of the conditions on the ground, particularly as teachers generally showed feelings of disillusionment, insecurity, confusion, anxiety and distress. It could be argued that these feelings resulted in a narrow scope of explanations which were rather difficult to transcend using the depth interviews. However, as Constable *et al.* (1994) state, "it is possible that the context of change is the factor in its implementation" (p. 48). This posed a methodological difficulty for as Cooper and McIntyre (1994) say:

... how can the researcher deal with the possibility that subjects might present merely plausible as opposed to authentic responses? ... [it] highlights the tension between the researcher's desire to answer specific questions and the necessity to be as non-directive as possible (p. 19).

The issue also raises ethical problems. Teachers were not to be treated with contempt or suspicion as were their responses. However, Brown and McIntyre (1995) acknowledge that access to professional craft knowledge is an area in its own right. Strategies have to be devised "to stimulate them [teachers] to articulate what is it they value in their own teaching, what they are trying to accomplish and how they achieve the things which they do well" (p. 17).

It could be implied that the research context itself sought more radical, innovative, adaptive, context-based or shaped strategies than those available in standard textbooks (e.g., Powney and Watts, 1987; Wragg, 1994). This is far from suggesting redundancy of interviews in fieldwork but

points to difficulties with realising their utmost potential within the context of this study. The situation negated the teachers' sense of their reality. The new curriculum appeared to be a self-perpetuating liability with its attendant problems, from teachers' perspectives. But, clearly, access negotiation is dependent on a wide range of factors some of which lie beyond the realm of merely supportive field relationships.

In the following sections, discussions focus on aspects of reflexivity and generalisability as they apply to the study.

11.3.0 Reflexivity

Recent qualitative literature clarifies the importance of researchers to see themselves as part of the research setting, and, in particular, urges them to reflect on how their presence influenced the events, data collection and analysis (see Hammersley and Atkinson, 1983; Hammersley, 1983; Arendell, 1997; Kociatkiewicz and Kostera, 1999; Blee, 1998). Van Maanen (1995) aptly calls the process, hence reflexivity, 'ethnography of ethnography'; Delamont (1992) sees reflexivity as "a social scientific variety of self-consciousness". It has been generally agreed that even an *unobtrusive* observer disturbs the 'natural' environment of the environment under study (see Hammersley, 1983; Delamont, 1992; Hitchcock and Hughes, 1992). In terms of data collection, there existed in the researcher an 'anthropologic frame of mind' (see also Delamont and Galton's (1986) concept of making the 'familiar strange'):

On the one hand it means the openness to new realities and meanings, on the other, a constant need to problematise, a refusal to take anything for granted, to treat things as obvious and familiar. The researcher makes use of her or his curiosity, the ability to be surprised by what she or he observes, even if it is 'just' the everyday world. The (anthropologist) looks at the mundane and sees things that are engaging, that constitute an intellectual challenge (Kociatkiewicz and Kostera, 1999, p. 37).

The presentation of research findings highlights and illustrates the above *basic* element of self-reflexivity in the study. Interviews are rarely acknowledged to have in-built self-reflexivity, asserts Arendell (1997, p. 342). The distinction between formal and in-depth interviews and their associated data collection strategies show how a search by interviewees for a deeper meaning of situations was constantly sought. Further discussions on reflexivity here are classed within two areas: researcher's self in schools and self-bias.

11.3.1 Researcher's self

With respect to collecting data in classrooms, my position has been described as based on participant observation. The basic precautions taken in acting out the position in the research mainly involved keeping a low profile. This has already been touched on in discussions about classroom observation. Scheduling of the interviews was yet another basic precaution followed in the field. Interviews with teachers, held after their scheduled set of observations was over, meant

that teachers had worked oblivious of my particular areas of interest and perspectives regarding the implementation of the curriculum. However, my presence in the field when teachers were faced with some difficulties with the curriculum, possibly influenced their perception of the research as well as my personal and professional identity or affiliation.

The problem here is that it is unclear how the structuring of the interview questions and the following up of 'significant leads' in interviewees responses communicated, if ever, my sense of sympathy, empathy and understanding of the situation. With the interpersonal approach adopted (see Henson *et al.*, 1976), interviewees constructed their own meanings of encounters and behaved in the manner they deemed appropriate. On the other hand, my being independent of the Ministry of Education, working for the University of Botswana, and the small age-gap I held with the interviewees were factors which could potentially influence the participants' behaviour. However, because of perspectives from different teachers widely supporting each other, it appears that the integrity of the data was not compromised. What has to be explored is the possible impact on the researcher on how the close correspondence of empirical evidence and teacher perspectives influenced the research itself.

The starting point here stems from my methodological stance, in particular, on whether or not the view that phenomena should be understood or appreciated from teachers' view points did not blind me or numb my perceptions to other aspects of reality. More appropriately, it is a question of whether or not I was stereotyped to perceiving some things and not others. Furfey's (1965) observation is borrowed and used here both as an analogy and metaphor. He states that "theoretical loyalty to democratic ideals may blind a man to the existence of social discrimination, even when he himself participates in it"

In this study, the clear empirical evidence of mismanagement of the curriculum (in terms of provision of proper resources) by the Ministry of Education, and how the effects of mismanagement were variously manifest in teaching might have warped my objectivity, reducing the rigour and vigour in interviews in general. For one thing it appears that teachers were not '*hard-pressed*' to show their accountability and to share in ensuring enhanced or successful implementation of the curriculum. There is no assertion here that my impression of teaching conditions resulted in a 'Halo Effect' (Furfey, 1965, p. 300) or, that it coloured elements in the research environment (*ibid.*) but, that the psychological and emotive positions that teachers seemed to be in at the time of the research made them vulnerable to interviews which might have sought to hold them accountable for what happened in their classrooms. My contention here is that the methodological position adopted in the research turned out to be 'naturally' sympathetic to the 'under-privileged' (see Furfey, 1965) or, as Coffey (1996) would say, "favours the underdog and 'gives voice' to the under-privileged and powerless groups" (p. 62). The methodological posture adopted favoured the situation and could lead to a possible lapse of judgement if things

are more predisposed to move in one direction than in the other. However, the methodological practices of triangulation and principled observation were widely used to guard against some personal errors of judgement and bias.

Beyond the methodological stance, my affiliation with education in Botswana made available a repertoire of knowledge with a potential to influence research. The most important concern was to avoid reading completely any literature on science education in Botswana during the course of the research. For instance, avoiding reading the qualitative report of a similar study conducted by Bob Prophet and Pat Rowell in CJSS in 1987-1988 (reviewed in Chapter 2). I therefore worked without prior knowledge of the salient elements of the teaching environment identified in the report or its subsequent journal articles. Besides the literature, three possible areas of bias in the research were identified. They are: social culture; personal experience in teaching and my science background. Each one area is discussed briefly.

11.3.2 Social culture

Being a native of Botswana, working in an area in which I have my ancestral roots and sharing a common language with both pupils and the majority of teachers, had both advantages and disadvantages. An advantage was that the shared social culture enhanced seeing some things *from* pupils' perspectives. For instance, extracting meaning from pupils' expressions of their experiences, mostly literal translations from Setswana to English, as reported in Chapter 6. This heightened awareness and sensitivity to such situations and influenced my interest of how teachers handled them. This was also a disadvantage for, to expect teachers to be equally discerning and perceptive, could be unreasonable and prejudiced. There was a risk of seeing the reactions outside the context of teachers' objectives and what they made of the contributions in relation to learning science.

Furthermore, my previous interest in cosmological ideas and constructivism in science teaching in Botswana which culminated in a manuscript entitled "Constructivism and Science Teaching in Botswana: A Case of Communication Breakdown?" increased my interest in determining the position in science teaching of both teachers' and pupils' predisposition to 'everyday examples' and experience-based forms of knowledge. The central position of the manuscript was that constructivist perspectives had not reached the bulk of science teachers across the country despite the local (i.e., within Botswana) interest and research. In general, the manuscript highlighted my sympathetic position to both teachers and pupils, particularly as it was developed amidst the decline (internationally) in general interest in constructivism. My expectations were particularly increased by the assumption that the teachers, having been trained for teaching in CJSS in colleges which were established as part of wider educational reforms of 1976, would not only be reasonably conversant with constructivist perspectives, but would also be able to apply them as

and when appropriate. However, the bias was useful as I could see more fully the *totality* of the teaching environment.

11.3.3 Personal experience in teaching science

I had a three- to four-month first-hand experience in teaching science in a CJSS in 1988 at Thamaga (a *typical* affluent rural settlement) as part of preparation for pursuing a Post Graduate Diploma in Education at the University of Botswana. The experience had given me some expectations on pupil enrolments and on the level of support teachers received from the Ministry of Education. At the time, the then school curriculum, modelled on the recommendations of the first National Commission on Education of 1976, and implemented starting in January 1986, was in its second year of use. With about 100 CJSS countrywide compared with the current 230, complete curriculum packages comprising textbooks, pupils worksheets, teacher guides and science equipment had been promptly delivered to schools. The package had been developed by the now defunct National Science Panel (Nganunu, 1990). The body also monitored its implementation. On the other hand, Primary School Leaving Examination (PSLE) results were used decisively to select pupils who enrolled into CJSS (see Prophet and Rowell, 1988). A small proportion of pupils with grade 'C', the last but first grade on the normative result classification scale were enrolled while the remainder, including those pupils with grade 'D', were allowed to repeat the final year of primary education. This was the case at the time of my internship at Thamaga CJSS. I thus went into schools with expectations to find a similar set of conditions. But as teachers' complaints about pupils abilities showed (Chapter 6), the situation was different during my research.

The situation vastly contrasted with my perceptions and experiences of the challenges of teaching at CJSS level. The background knowledge influenced my understanding of teachers' views of *disorganised* support rendered by the Ministry of Education. However, interestingly, I realised the vast difference existing between qualitative classroom observations in this study and the 'evaluative' observations of trainee teachers on internships in schools. The latter part falls within the realm of my duties as teacher trainer. The difference helped me to realise that the fieldwork was akin to turning a new leaf both in my professional and academic development.

11.3.4 Science background

My association with science (physics), studied for a combined total of five years and teaching it to some diploma students at university level, gave me a rather positivistic and quantitative worldview. It also had an impact on my perception of research and associated routines or conventions. Pursuing a qualitative approach in this case study necessitated a change in attitude and acceptance that I was learning something new. Two key challenges were met. The data analysis in this study became a challenge because of the comparatively high *fluidity*, low operational detail and precision of some key concepts in qualitative methodology. For instance, concepts of

triangulation, validity, reliability, inferring and drawing valid conclusions from data. However, my science background has been more helpful than handicapping as I could seek meanings and interpretations of some concepts from a positivistic vantage point. Another challenge was in writing, in particular, the art of presenting findings objectively. Writing required more creativity than was anticipated (see Woods, 1985). The challenge also involved adopting typical 'conventions' and structure of writing in qualitative research. Woods' (1979) "The Divided School" and Delamont and Galton's (1986) "Inside the Secondary Classroom" became useful references in terms of developing arguments and shaping my work.

The next two sections focus on the generalisability of research findings and on a short summative overview of the research. They both conclude debates on methodological issues.

11.4.0 Generalisability of Research Findings

Generalisability of findings here is taken to carry similar meaning as the concept of 'external validity' in quantitative research. The literature shows that generalisation of qualitative research findings is fraught with controversy. There appears to be no universal and clearly defined position on the matter. The main problem which could be noted on the subject is that the debates in the literature are based on principles of the qualitative research paradigm on which case study and ethnography rely. Various positions on the subject are rehearsed here before presenting those posited for the study. Firstly, the strength of qualitative research, particularly case studies and ethnographic research, is found to be in their internal validity (see, e.g., Guba and Lincoln, 1981; Anderson and Arsenault, 1998). Woods (1979) elaborates:

Some see it (i.e., ethnography) as exclusively idiographic, that is to say, descriptive of particular situations; these emphasise the holistic nature of ethnography and the distinct nature of information discovered, which consequently is not covered by the assumptions of statistical assessment. It does not in itself, therefore, permit generalisation, though it might serve as a basis (pp. 267-268).

However, Anderson and Arsenault (1998) hold a more positive and different view that "the case study method .. in its best form, is valid, rigorous and often generalisable" (p. 152). Atkinson and Delamont (1985) too embrace the position despite their being dismissive of case study research:

... it is simply not true that the traditions of qualitative research from which case study research draws inspiration eschews generalisation ... In fact, the development of ethnographic work in sociology and anthropology rests on a principle of comparative analysis (p. 39).

The view closely matches Peter Woods' other position on ethnography:

... there are those who prefer to see it as nomothetic, that is to say, generalising, comparative, theoretical ... My own view is that 'idiographic' and 'nomothetic' approaches are not mutually exclusive, and that we can have both rich and intensive description and generalisability (1979, p. 268).

The position of generalisation in case study has also been seen in terms of purpose of the research. As Vulliamy (1990a) asserts that those:

.. usually adopting a qualitative strategy, are more interested in providing deeper understanding of the characteristics of the totality of a single institution. The latter is done in the hope that the ensuing generation of theoretical ideas might illuminate the process of schooling elsewhere, but not with the intention that any specific findings should be generalisable (p. 12).

Thus, it can be argued that research studies which are conducted for their *own sake* may appear 'foolhardy' if they are exclusive to offer no hope of applicability to some other contexts. The other concern is that the uniqueness of any particular social situation as seen by a researcher is neither easily tenable nor absolute so long as the research setting and populations are networked to the outside world. Some difficulties with generalisability of qualitative findings are borne of the fact that, as Nunan (1996) states, there is that "difficulty of arguing from the single instance to the general". Poppleton (1975) takes the issue further though the arguments are a bit odd as a naturalistic setting is not in the first instance seen in terms of identifiable and discrete variables. Poppleton states that:

... in order to be able to generalise from one naturalistic setting to another, researchers must identify their sample of classes in terms of pupil, task, architecture and organisational activities. The organisational task variables may clearly be represented by classroom settings, and generalisation will be impossible unless the structural characteristics of different classroom environments are given a clear conceptual definition (p. 253).

Notwithstanding such controversies, and moving away from the rhetorical to a pragmatic position, Anderson and Arsenault (1998) says:

The extent to which generalisability or external validity is possible will relate to the extent to which a case is typical or involves typical phenomena. ... These have been turned into what are referred to as 'Lessons Learned'. A lesson is something derived from a given case but which has potential generalisability to other situations and settings (pp. 159-160).

Here I would adopt a moderate and pragmatic stance: although wholesale generalisations of findings might not be possible, there are 'lessons learnt' from the study which could be applicable elsewhere in Botswana, or perhaps, be used as starting points for research (cf. Delamont and Hamilton, 1975, p. 13). As Furfey (1965) has argued:

A few cases, no matter how collected, or even a single indubitable case, will be sufficient to prove at least that a certain phenomenon is possible. Here the logical axiom applies, *Ab esse ad posse valet illatio* ("Inference from existence to possibility is valid inference"). ... In the meantime, however, the mere knowledge of what can happen, knowledge of the range covered by exceptional behaviour, is itself valuable to science, and the study of even haphazard cases can be useful in this way (p. 341 - 344).

The position adopted here seems to derive support from the wider organisational framework of the education system in Botswana. The large-scale implementation of the curriculum; the large-scale educational establishment with schools built to the same design and administrative set-up; and the centralised control of education comprise the key aspects of the environment which enhances the possibility of findings from this study being applicable elsewhere. The second point concerns the weak 'resourcing' of the curriculum (e.g., lack of proper textbooks, teachers' guides) which was universal in Botswana as evidenced by documents from the Ministry (e.g., book prescription lists; sample examination papers). In that way, the problems teachers faced in the actual course of teaching might not be peculiar to the group in the study.

Also, teachers' perspectives on the implementation of the curriculum were definitely highly problem-oriented and did not, in general, show a strong and conclusive link between decision-making (i.e., intellectual and cognitive processes) and application teaching. Their positions were thus not idiosyncratic *per se* but tended to speak for the teaching fraternity. This is what makes generalisations as 'lessons learned' (Anderson and Arsenault, 1998) feasible at macro-level but rather comparatively weak or inconclusive at level of class instruction. Also, the exploratory nature of the study, the involvement of 26 science teachers in eight schools, has blurred the distinctiveness and the peculiarities of individual schools. The concern was with building a picture of and giving insights into science teaching in a 'typical' rural environment. Thus the deliberate choice in the study of the rural and not urban locality as the macro-context of the research is also a very important consideration in the debates on how generalisable the research findings are.

11.5.0 Summative overview

This chapter sought to explore relationships between field research methods and research findings, self-reflectively and self-reflexively. The case study fieldwork is inductive in nature and has led to a generation of some substantive conclusions on the implementation of the science curriculum. The issue of their generalisation is seen from a pragmatic vantage point and within the very attributes of the study itself. As stated, the study was exploratory and did not place emphasis on peculiarities of schools and the wider locality in which the schools were located. Teachers themselves emphasised the wider issues on management of the curriculum - further increasing possibility applicability of lessons learnt to other areas in typical rural settings.

The operative context in the study was that of participant observation and of searching for and respecting teacher perspectives on the observed practice. But quite clearly, teachers' perspectives were mainly on the management of the curriculum. The study data is devoid of a conclusive link in decision-making between teachers' intention and their actions in classroom. This is significant in two ways. Firstly, it can be said that there was a pronounced element of potential cause and

effect relationships in the environment studied. In other words, while teacher's explanations provided some in-depth understanding of the environmental factors impinging on the implementation of the curriculum, one cannot safely extrapolate or infer that what was observed in class (i.e., teacher practice or action) resulted exclusively from those factors. The second significance is methodological, and follows from the previous observation.

There was "incongruence" between the observers' perspective as captured in the classroom observation schedules and in the teacher's perspectives from interviews. The 'incongruence' is that observations were in terms of teacher practice but teachers' explanations were in terms of mismanagement of the curriculum by the Ministry of Education. This could be difficult to comprehend because the interviews were conducted to establish the teachers' value perspectives on using the curriculum, and to give their "cultural understanding of the process, of the complex interactions that come into play when innovative practices are introduced into an existing system" (cf. Logsdon *et al.*, 1988, p. 24). Here it could be said that teachers adopted a holistic position giving relational aspects of their practice as they saw, experienced, and knew them to be. They gave "insiders' accounts" (i.e., the 'emic' according to Guba and Lincoln, 1988, p. 108) which made "explicit the underlying patterns and hidden rules which regulate classroom life" (Power, 1977, p. 21).

As per the adage, "only the pot knows the fire": the outsiders' accounts (i.e., Guba and Lincoln's 'etic') cannot be expected to correspond wholly with the 'emic'. Here Scott and Usher (1999) provide a very critical review of the situation. They say that by placing stress on descriptions and observations of phenomena, the tendency is to fail to position the actors' activities within the enabling and constraining contexts of life. "The emphasis is on the agential thrust of activity, with a consequent neglect of structural influences" (p. 48). Also, the participant observation fly-on-the-wall-style means that 'incongruence' between the researchers' observation and participants value positions should not be surprising. As Scott and Usher state, if the objective is the "fusion of horizons ... in which the observer and the observed fuse their different versions of the world, then such a detached stance [i.e., participant observation] is considered illegitimate" (p. 102). However, the research findings are significant in many ways. Of interest is the fact that it has also uncovered some aspects of the impact of basic education on teaching particularly through teachers' views of their pupils. This and many other findings are discussed in the chapter on interpretation of findings.

In conclusion, the case study approach adopted in this study allowed for relatively long and sustained firsthand contact with participants and the research environment. This permitted multiple occurrences, in different forms and shape, of the diverse but salient elements in the implementation of the curriculum. The study thus differs from some other studies in which the time available was a key restriction. For instance, a seven day case study of a school (see

Atkinson and Delamont, 1985, p. 33) and Alderman and Walker's (1975) one-week school case studies. According to Stenhouse (1983), time restrictions means that the "balance of fieldwork naturally swings from observations towards interviewing" and that observation, though highly valued, is restricted and therefore limited in penetration.

The significant aspect of this study is that it used in the field some relatively comprehensive, elaborate and exhaustive strategies in data collection and analysis involving over a long-term aspects of self-interrogation and self-reflection. Consequently, the outcomes of the study can be claimed to have enhanced credibility and trustworthiness to effectively provide an in-depth understanding of some key factors in the implementation of the curriculum. However, the study was condensed in a relative sense. This is premised on the view that the study of classroom culture needed more time than the nine-months that was available for fieldwork. The focus on classroom interactions and making the class a unit of analysis is another aspect of the study which showed how it was fitted to the time available.

Finally, the research findings support Vulliamy's (1990e) observation that "qualitative methods can alert educational policy maker to any unforeseen or facilitating factors that may emerge at the grassroots level of individual schools and classrooms" (p. 153). The factors have been presented in Chapters 5-8. They would not have made meaningful sense without an understanding of research processes used in the field.

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Notes

1. Some schools had to do without a tea-break. Water shortage also paralysed the delivery of bread which might have been part of a day's first meal for some pupils. Schools in Botswana, because of the diverse socio-economic status of rural populace, have traditionally become *feeding-centres* for pupils such that proper meals are served at lunch. Health Centres cater for destitute and under-school age children (i.e., below age 7). This has helped keep nutrition levels of the nation high since independence in 1966.

The village experienced water crisis again in February because boreholes which provide the village with water were drying out. The country has been experiencing drought since the Mid-80s to date. One deputy school Head for a CJSS in the village was quoted as saying: "We are forced to dismiss students at lunch time when there is no water in the school as they (Kitchen staff) struggle to get water from the tank where students also drink from" ("Water Crisis", 1999, p. 6). According to the source, "Although there is a total of 13 boreholes around the village X [name given], they cannot provide at least 3000 cubic litres necessary to feed the village everyday. Instead only 2750 is retrieved from underground" (ibid.).

2. The literature shows the existence of constructs similar in meaning to 'professional craft knowledge'. For instance, the terms 'practical theory' and 'educational platform'. Kettle and Sellars (1996) explain: "a person's 'educational platform' is composed of the assumptions, theories, and beliefs one holds for key aspects of effective teaching, such as the purpose of schooling, perception of students, what knowledge is most worth, and the value of certain teaching techniques and pedagogical principles" (p. 2).

APPENDIX 12**3-YEAR J.C. SCIENCE SYLLABUS****IT RUNS FROM PAGE 299 TO PAGE 326.****N.B. THE ORIGINAL PAGE NUMBERS OF THE DOCUMENT HAVE BEEN
RETAINED.**

FOREWORD

It is with pleasure that the Ministry of Education is issuing this syllabus of the last three years of the Ten Year Basic Education Programme as part of the implementation of Revised National Policy on Education (Government Paper No. 2 of 1994). It is our goal that the Revised National Policy on Education will be our Education Blueprint for the next twenty five years. It will provide guidance to Government in the development of an education system that will prepare Batswana for the transition from a traditional agro-based economy to the industrial economy that the country aspires for. The development of this syllabus takes cognisance of this overall goal of the education system.

The implementation of this syllabus begins with the Form 1 intake of 1996. The syllabus offers learning opportunities targeted at addressing the broad intentions of the policy. To satisfy these expected outcomes, the syllabus focuses on the development of skills, attitudes, values and knowledge students are expected to demonstrate by the time they complete the junior secondary course. The content has been selected from the students' immediate environment to facilitate understanding and ease of transfer of skills and knowledge to real life situations. What happens in the classroom must lead to informed and empowered citizens who can meet the challenges of the 21st century. We believe that this syllabus will assist in this regard.

Deliberate attention has been paid to infuse and integrate issues raised by the 1994 Revised National Policy on Education such as; Environmental Education, Population Family Life Education, HIV/AIDS Education and the world of work. The major focus of the junior secondary programme is to improve the quality of education by broadening the opportunities for success for learners of varying capabilities in their educational endeavours. Further, the programme aims at creating and sustaining conducive environments for learning and teaching to allow students to excel within their own capabilities.

Batswana strive to carry out their development efforts with a firm belief in consultation. To this end, no effort has been spared in consulting all stakeholders in the design of this syllabus. Review and revision of the curriculum to address the new three year Junior Certificate programme began in 1994 under the direction and leadership of the Department of Curriculum Development and Evaluation through its Curriculum Development Division. Such work was undertaken with the close co-operation and support from private citizens, various Departments and Divisions of the Ministry of Education and other ministries, teachers throughout the country as well as members of Task Forces from various institutions with vested interest in the products of our education system. If the goal of transforming Botswana's economy is to be achieved there is no better strategy of developing educational programmes than that of involving all the stakeholders in the process. The Ministry of Education would like to commend all those who participated in the development of the junior secondary syllabi for their professional commitment and support.

The Ministry of Education believes that a high-quality system of education open to all is imperative for social upliftment. In addition diversity strengthens society. It is our hope that these traits are found in our education system. This syllabus attests to the importance that the Government of Botswana attaches to the provision of a sound basic education programme.

Finally, I wish to record my appreciation and thanks to all those involved in the publication of this document.



P. O. Molosi
Permanent Secretary
Ministry of Education

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INTRODUCTION

The science syllabus is designed to cater for students who will proceed to senior secondary education or vocational training and those who will leave at the end of form three to the world of work. In teaching the syllabus, it should be realised that when children come to school, they come not with blank minds, but with some knowledge, skills, attitudes and beliefs. Some of these experiences may become useful or inhibitive during the teaching/learning process, and so teachers have to be aware of these earlier experiences to more effectively communicate understanding through recognising individual abilities, interests and needs.

This syllabus document has been divided into two parts. The first part is an introduction which

- describes the syllabus layout,
- outlines the rationale for the Ten-Year Basic Science programme,
- states the aims of Ten-Year Basic Education Programme,
- states the aims of the Ten-Year Basic Science Education Programme,
- states the aims of the Three-Year Science syllabus and finally
- describes assessment features of the programme that can help teachers monitor students' progression.

The second part details outlines for Forms 1, 2 and 3.

The syllabus is organised into ten broad themes called modules. The modules are introduced in form 1 or 2 and further developed during the later years. Module 1 is all presented in form 1 because it introduces basic scientific skills needed to work properly and safely in science. These skills should be applied right through the three years.

Each module is sub-divided into units. From units, topics have been chosen to allow the scientific processes to function and help students acquire knowledge which will enable them to understand some science concepts. For each topic general objectives which give rise to specific objectives have been derived. The specific objectives describe what students are expected to do; this includes applying basic science process skills, interpreting natural phenomena, understanding and applying scientific principles. A deliberate effort has been made to show the relationships among the disciplines of

science and technology. Issues on population/family life education, environmental education, HIV/AIDS education and concepts relating to the world of work have also been included in the syllabus.

The syllabus has been developed on the assumption that science will be allocated 5 periods per week (2 hr. 55 min.) on a 45 period x 35 minutes per week timetable. The syllabus also indicates approximate period allocation per unit.

RATIONALE *non-formal-visit ok*

Science by its nature involves experimental activities characterised by inquiry methods of learning. Through learning science, children can understand the rapidly changing environment around them. Children learn about objects and events by asking questions, investigating and experimenting to find appropriate answers. This scientific method of inquiry develops in children skills and attitudes that facilitate the learning of science and even other subjects. Specifically, science gives children the opportunity to:

- acquire basic scientific knowledge
- apply the acquired knowledge to new situations
- use the acquired scientific knowledge and skills in solving problems
- see relationships among the basic scientific concepts learnt
- process information at their disposal scientifically

Science plays a central role in society by helping children gain an understanding of the scientific and technical aspects of the society in which they live. Using the scientific approach provides children with a better ability to use the knowledge they have acquired and to cope with the ever-changing technological developments that have become so much a part of our lives.

AIMS OF THE TEN-YEAR BASIC EDUCATION PROGRAMME

On completion of the Ten-Year Basic Education Programme, each student is expected to accomplish the following fifteen basic aims:

1. Develop competency and confidence in the application of computational skills in order to solve day-to-day problems.

- them for living in a changing world. It is intended, therefore, that by the end of the ten-year science programme children are expected to have:
1. developed competency and confidence in the application of computational skills in order to solve day-to-day problems.
 2. developed critical thinking, problem-solving ability, individual initiative, interpersonal and inquiry skills.
 3. developed the ability to express themselves clearly in English, both orally and in writing, using it as a tool for learning science.
 4. developed desirable attitudes towards science-related work and the ability to assess personal achievement and capabilities realistically in the pursuit of appropriate career/employment opportunities and/or further education.
 5. acquired knowledge, skills, and attitudes in food production and industrial arts for self-reliance and self-sufficiency.
 6. developed awareness and/or literacy and understanding of the significance of computers in the world of work.
 7. acquired knowledge and understanding of their environment and the need for sustaining utilisation of natural resources.
 8. developed desirable attitudes/behavioural patterns in interacting with the environment in a way that is protective, preserving and nurturing.
 9. acquired the basic science knowledge and skills, including basic knowledge of the laws governing the natural world.
 10. acquired good knowledge and practice of moral standards and health practices that will prepare them for responsible family and community life.
 11. acquired an appreciation of technology and technological skills including basic skills in handling tools and materials.

2. Develop an understanding of business, everyday commercial transactions and entrepreneurial skills.
3. Develop critical thinking, problem-solving ability, individual initiative, interpersonal and inquiry skills.
4. Develop desirable attitudes towards different types of work and the ability to assess personal achievement and capabilities realistically in pursuit of appropriate career/employment opportunities and/or further education.
5. Acquire knowledge, skills, and attitudes in food production and industrial arts for self-reliance and self-sufficiency.
6. Develop awareness and/or literacy and understanding of the significance of computers in the world of work.
7. Acquire knowledge and understanding of their environment and the need for sustaining utilisation of natural resources.
8. Develop desirable attitudes/behavioural patterns in interacting with the environment in a way that is protective, preserving and nurturing.
9. Acquire knowledge and understanding of society, appreciation of their culture including languages, traditions, songs, ceremonies, customs, social norms and a sense of citizenship.
10. Develop the ability to express themselves clearly in English, Setswana and a third language both orally and in writing, using them as tools for further learning and employment.
11. Acquire the basic science knowledge and skills, including basic knowledge of the laws governing the natural world.
12. Acquire good knowledge and practice of moral standards and health practices that will prepare them for responsible family and community life.
13. Develop their own special interests, talents and skills whether these be dexterity, physical strength, intellectual ability, and/or artistic gifts.
14. Acquire an appreciation of technology and technological skills including basic skills in handling tools and materials.
15. Gain the necessary knowledge and ability to interact with and learn about their community, the government of their country and the world around them.

AIMS OF THREE-YEAR JUNIOR SECONDARY SCIENCE PROGRAMME

At the end of three years of Junior Secondary Science Programme, students are expected to have developed:

1. an understanding of basic principles and concepts of science as they are experienced in everyday life.
2. positive attitudes towards scientific skills such as curiosity, open-mindedness, creativity, objectivity, integrity and initiative.

AIMS OF THE TEN-YEAR SCIENCE PROGRAMME

Science learning during the ten years should draw from and apply to living experiences in an effort to give children practical, relevant and meaningful experiences in preparing

3. an ability to use process skills associated with the practice of science for understanding and exploring natural phenomena, problem-solving and decision-making.
4. an awareness and appreciation of the interrelationships among science, technology and society in the context of science and everyday life.
5. an awareness, literacy and an understanding of the significance of computers in the science related careers.
6. the ability and responsibility to protect the environment and use natural resources on a sustainable basis.
7. the ability to make informed decisions about further studies and science-based careers and vocations.

ASSESSMENT

The assessment for this science syllabus consists of a terminal examination and continuous assessment. The Junior Certificate Examination will be produced by the Examinations, Research and Testing Division and the continuous assessment is to be undertaken by the teacher for students' progression. The latter will complement the former by supplying information about the student's potential.

Junior Certificate Science Examination

The examination will consist of three papers, namely:

Paper 1: Objective type questions; testing knowledge and understanding of scientific concepts; application of scientific knowledge and understanding to new situations.

Paper 2: This will be made up of two sections (Sections A and B):

Section A, Short-answer questions; knowledge and recall of scientific concepts; understanding of scientific knowledge and relationships; translation of information from one form to another: reading information from graphs, tables and charts; representing information in the form of graphs, tables and charts.

Section B, Description/essay and problem-solving questions; translation of information from one form to another: reading information from graphs, tables and charts; representing information in the form of graphs, tables and charts; application of scientific knowledge and understanding to new situations: explanation; interpretation and application of information; analysis, synthesis and evaluation of scientific information; planning of investigations.

Paper 3: A series of questions to test past experience of practical work; planning of investigations; designing and planning an experimental procedure; use of apparatus and materials; record observations and measurements; interpret and draw conclusions from observations and experimental data

Continuous assessment

CA for students' progression will be undertaken by teachers throughout the three years.

These may be made up of the following activities done by the students:

- Written tests during the three years: Items should match the skills being measured and not the convenience of the teacher.
- Normal laboratory work: Teachers will have to administer far more individual practical work than ever before. This will entail obtaining and maintaining sufficient equipment, making and keeping to schedules, creating and maintaining records.
- Project work: Through project work, the teacher gets to know about the student's learning and attitude. The teacher is expected to put the responsibility for learning on the student and may involve the student's family and community. Several projects could be contemplated during the three years, with expectations for improvement as students gain experience. Students should be encouraged to choose their own project topics in consultation with teachers.

FORM 1

MODULE 1: THE SCIENTIFIC METHOD AND PRECAUTIONS

UNIT 1.1 - HOW SCIENTISTS WORK (10 periods)

<i>Topics</i>	<i>General Objectives</i>	<i>Specific Objectives</i>
	<i>The students should be able to:</i>	<i>The students should be able to:</i>
Doing science	1.1.1 acquire basic process skills to carry out investigations using scientific method and develop an interest in science.	1.1.1.1 explain what science is. 1.1.1.2 discuss how science affects our everyday life. 1.1.1.3 observe people with science-related careers in their working environments (use of video cassettes and guidance materials recommended). 1.1.1.4 demonstrate the following process skills suitable for simple investigations: observing, comparing, classifying, measuring, interpreting, analysing, inferring, predicting, formulating hypothesis, controlling variables, experimenting, (designing and carrying out procedures), problem solving and communicating in daily life situations. 1.1.1.5 infer correctly relations of variables from experimental results presented in tables, graphs, observations. 1.1.1.6 make reasonable conclusions on the basis of available experimental results.
Applications of science in everyday life	1.1.2 appreciate applications of science skills in everyday life.	1.1.2.1 carry out an investigation on any problem in daily life which lends itself to experimentation involving the use of simple laboratory apparatus. - <i>Experiments</i> 1.1.2.2 carry out a scientific investigation over a longer period of time using a theme related to daily life science situations.
Safety awareness	1.1.3 acquire basic knowledge, skills and techniques needed to work safely in the laboratory.	1.1.3.1 describe what safety is and what a safe place is. 1.1.3.2 state common hazards in the laboratory. 1.1.3.3 list safety rules applicable in the laboratory. 1.1.3.4 demonstrate safe behaviour in a laboratory.
First aid	1.1.4 acquire basic first aid skills in handling common injuries or minor accidents.	1.1.4.1 define first aid. 1.1.4.2 demonstrate some simple first aid techniques: treating bites, burns, shock, poisoning and controlling bleeding.

UNIT 12 - MAKING MEASUREMENTS (10 periods)

<i>Topics</i>	<i>General Objectives</i>	<i>Specific Objectives</i>
Reading scales of measuring instruments	1.2.1 acquire skills in reading scales of instruments using divisions and sub-divisions of standard units of the metric system.	1.2.1.1 accurately read the scale of a measuring instrument to its smallest division.
Measuring length	1.2.2 perform estimations and accurate measurements of length.	1.2.2.1 estimate length of common objects to the nearest centimetre. 1.2.2.2 carry out experiments using rulers and metre rules to measure lengths to the nearest millimetre. 1.2.2.3 convert given measurements in traditional and non standard units into metres.
Measuring area	1.2.3 perform estimations and accurate measurements of area.	1.2.3.1 estimate the area of any common shape. 1.2.3.2 determine area of an irregular object such as a leaf. 1.2.3.3 design suitable methods for measuring areas in daily life situation.
Measuring mass	1.2.4 perform estimations and accurate measurements of mass.	1.2.4.1 estimate mass of common objects. 1.2.4.2 read the scales of a triple beam balance or a lever arm balance to the nearest gram. 1.2.4.3 design suitable methods for measuring mass in daily life situations.
Measuring volume	1.2.5 perform estimations and accurate measurements of volume.	1.2.5.1 estimate volume of a liquid or an object. 1.2.5.2 read the scales of a measuring cylinder (thinking of the following: level surface, meniscus, parallax error) to the nearest cubic centimetre (cm ³). 1.2.5.3 design suitable methods for measuring volume in daily life situations given a variety of objects and suitable measuring devices. 1.2.5.4 carry out accurate measurements of irregular objects floating and sinking using displacement cans and measuring cylinders.
Density	1.2.6 be aware of the relationship between mass and volume.	1.2.6.1 define density as mass per cubic centimetre of that substance. 1.2.6.2 compare masses of different substances of the same volume. 1.2.6.3 determine densities of different substances.
Measuring temperature	1.2.7 perform estimations and accurate measurements of temperature.	1.2.7.1 estimate temperature. 1.2.7.2 state that temperature is the degree of hotness/coldness. 1.2.7.3 read the scales of a laboratory thermometer to the nearest degrees Celsius (°C). 1.2.7.4 read the scales of a clinical thermometer to the nearest 1/10 °C.
Measuring time	1.2.8 perform estimations and accurate measurements of time.	1.2.8.1 estimate time to the nearest minute. 1.2.8.2 read the scales of a stop watch or a stop clock to the nearest second (s). 1.2.8.3 design suitable methods for measuring time.

MODULE 2: MATTER

UNIT 2/1 – WHAT IS MATTER? (10 periods)

<i>Topics</i>	<i>General Objectives</i>	<i>Specific Objectives</i>
Understanding matter	2.1.1 be familiar with concept "matter".	2.1.1.1 define what matter is. 2.1.1.2 describe that matter is made up of particles. 2.1.1.3 list properties of matter. 2.1.1.4 carry out activities to demonstrate these properties.
States of matter	2.1.2 comprehend the properties of the different states of matter.	2.1.2.1 identify the three different states of matter using water as an example. 2.1.2.2 compare properties of gases, liquids and solids and correlate them with particle arrangement (compressibility, heat expansion, hardness, density). 2.1.2.3 define diffusion as movement of particles from high concentration area to low concentration area until evenly distributed. 2.1.2.4 demonstrate diffusion in solids and fluids. 2.1.2.5 describe some properties of the different states of water. 2.1.2.6 state some of the uses of the different states of water.
Changes of state of matter	2.1.3 be aware of the changes of states.	2.1.3.1 demonstrate the changes of state of matter. 2.1.3.2 interpret changes of state as rearrangement of particles. 2.1.3.3 distinguish between evaporation and boiling.

UNIT 2/2 – LIVING MATTER (10 periods)

<i>Topics</i>	<i>General Objectives</i>	<i>Specific Objectives</i>
Characteristics of life	2.2.1 be familiar with the characteristics of life.	2.2.1.1 distinguish between living and non-living things. 2.2.1.2 observe and describe the characteristics of living things.
Classification of living things	2.2.2 understand the basis of classification of living things.	2.2.2.1 construct simple keys to classify living things. 2.2.2.2 identify basic principles of classification of living things.
Plant and animal cells	2.2.3 be aware of the fact that the cell is the building unit in organisms.	2.2.3.1 identify the cell as the basic unit of plants and animals. 2.2.3.2 observe different types of cells. 2.2.3.3 identify the main parts of plant and animal cells; nucleus, cytoplasm, cell wall, cell membrane, vacuole. 2.2.3.4 state the function of each of the above named parts. 2.2.3.5 identify differences in structure and function between plant and animal cells. 2.2.3.6 use bioviewers and microscopes to identify a variety of animal and plant cells. 2.2.3.7 prepare a wet mount slide of a simple plant cell e.g. onion cell or leaf epidermis. 2.2.3.8 use the microscope to examine the prepared slide.

Cells, tissues, organs and systems in plants and animals	2.2.4 understand the functions of cells, tissues, organs and systems in plants and animals.	2.2.4.1 state that multicellular living things are made up of different kinds of cells which carry out different functions. 2.2.4.2 define tissue, organ, and system. 2.2.4.3 give examples of cells, tissues, organs and systems in plants and animals.
MODULE 3: FAMILY LIFE EDUCATION		
UNIT 3.1 – HUMAN GROWTH AND DEVELOPMENT (10 periods)		
<i>Topics</i>	<i>General Objectives</i>	<i>Specific Objectives</i>
Physical development and puberty	3.1.1 be aware of the physical and behavioural changes they undergo as they grow up and acquire positive attitudes about their sexuality.	3.1.1.1 describe changes that occur in their bodies as they grow from birth: change in mass, height, development of bones and muscles. 3.1.1.2 describe changes which occur in girls at puberty. 3.1.1.3 describe the menstrual cycle in terms of ovulation, fertile period, menstruation. 3.1.1.4 describe changes which occur in boys at puberty (include wet dreams). 3.1.1.5 state that changes at puberty are controlled by chemicals called hormones. 3.1.1.6 list 3 hormones responsible for changes at puberty (oestrogen, progesterone and testosterone). 3.1.1.7 describe the functions of the hormones mentioned above. 3.1.1.8 predict consequences accompanying changes at puberty. 3.1.1.9 state what menopause is.
Parts of the reproductive system	3.1.2 acquire knowledge about human reproductive parts.	3.1.2.1 distinguish between the male and the female sex cells: size, structure and mobility. 3.1.2.2 describe the functions of parts of the female reproductive system: ovary, fallopian tubes, uterus, cervix and vagina. 3.1.2.3 describe the functions of parts of the male reproductive system: scrotum, testis, sperm duct, prostate gland, penis and urethra.
UNIT 3.2 – FAMILY PLANNING (5 periods)		
<i>Topics</i>	<i>General Objectives</i>	<i>Specific Objectives</i>
Methods of birth control	3.2.1 acquire basic knowledge about the use of a variety of birth control methods.	3.2.1.1 discuss the implications of family planning in the light of family size. 3.2.1.2 discuss the different methods of birth control. 3.2.1.3 discuss the advantages and disadvantages of various methods of birth control. 3.2.1.4 identify outlets that provide family planning advice and services.

UNIT 3.3 – SEXUAL BEHAVIOUR PROBLEMS (10 periods)

Topics	General Objectives	Specific Objectives
Teenage pregnancy	<p>3.3.1 recognise and appreciate sexual behaviour problems associated with adolescents.</p> <p>3.3.2 acquire skills to take the right decision to avoid pregnancy.</p>	<p>3.3.1.1 state the physical risks associated with teenage pregnancy.</p> <p>3.3.1.2 describe consequences of induced abortion.</p> <p>3.3.2.1 discuss the social implications of teenage pregnancy.</p> <p>3.3.2.2 discuss precautions required of teenagers to prevent pregnancy.</p>
Sexually transmitted diseases and HIV/AIDS	<p>3.3.3 acquire basic knowledge of sexually transmitted diseases and HIV/AIDS and be aware of their prevalence and seriousness.</p>	<p>3.3.3.1 list common sexually transmitted diseases e.g. AIDS, gonorrhoea, syphilis, thrush, genital herpes, genital warts, chancroid and chlamydia.</p> <p>3.3.3.2 describe signs, transmission and treatment of sexually transmitted diseases: syphilis, gonorrhoea, herpes and thrush.</p> <p>3.3.3.3 explain complications of untreated STDs.</p> <p>3.3.3.4 describe transmission of HIV.</p> <p>3.3.3.5 state that a person infected with HIV may appear normal.</p> <p>3.3.3.6 state the conditions of advanced AIDS patients.</p> <p>3.3.3.7 state how HIV/AIDS/STDs infection can be prevented.</p> <p>3.3.3.8 interpret statistical information on STDs and HIV/AIDS cases in Botswana.</p>

MODULE 4: WATER

UNIT 4.1 – WATER IN BOTSWANA (15 periods)

Topics	General Objectives	Specific Objectives
Sources of water	<p>4.1.1 be aware that water is an important natural resource.</p> <p>4.1.2 acquire basic knowledge about sources of water in Botswana.</p> <p>4.1.3 appreciate the importance of underground water in Botswana.</p>	<p>4.1.1.1 describe the stages of water cycle as evaporation, condensation and precipitation (rainfall, hail etc.).</p> <p>4.1.2.1 describe the two main sources of water in Botswana as underground and surface water.</p> <p>4.1.2.2 classify different reservoirs as underground and surface water in Botswana.</p> <p>4.1.2.3 describe how borehole water collects.</p> <p>4.1.2.4 explain how boreholes are made to obtain the water so formed.</p> <p>4.1.3.1 discuss the importance of underground water in Botswana.</p>
Uses of water	<p>4.1.4 know the importance of water in agricultural and industrial sectors.</p> <p>4.1.5 appreciate the value of water.</p>	<p>4.1.4.1 describe the uses of water in industry (such as for cooling machines, making products and dissolving substances).</p> <p>4.1.4.2 describe the uses of water in agriculture.</p> <p>4.1.5.1 discuss the effect of lack of water on animals and plants.</p>

Storage and conservation of water	4.1.6 be aware of the need and methods of storing and conserving water commonly used in Botswana. 4.1.7 appreciate the need to store and conserve water.	4.1.6.1 discuss the importance of storage of water in Botswana. 4.1.6.2 describe the various methods of storing water in Botswana. 4.1.6.3 identify the different methods of water storage used in industry and agriculture. 4.1.7.1 explain why it is essential to conserve water. 4.1.7.2 list ways of conserving water.
MODULE 6: ENERGY		
UNIT 6.1 – FORMS OF ENERGY AND ENERGY CHANGES (10 periods)		
<i>Topics</i>	<i>General Objectives</i>	<i>Specific Objectives</i>
Sources of energy	6.1.1 be aware of what energy can do. 6.1.2 be aware of the major sources of energy.	6.1.1.1 describe energy as the ability to do work. 6.1.2.1 identify different sources of energy: Sun, fossil fuels, food. 6.1.2.2 classify sources of energy as renewable and non-renewable. 6.1.2.3 describe different forms of energy.
Energy changes	6.1.3 be aware of various transformations of energy.	6.1.3.1 describe energy conversions/changes using different types of energy. 6.1.3.2 state applications of energy changes in everyday life.
Conserving energy	6.1.4 understand the need to conserve energy. 6.1.5 be aware of alternative sources of energy available in Botswana.	6.1.4.1 discuss the need to conserve energy. 6.1.4.2 describe origin of fossil fuels. 6.1.4.3 describe uses of fossil fuels. 6.1.5.1 list alternative sources of energy available in Botswana (wind, solar and biogas). 6.1.5.2 describe how each alternative source of energy may be harnessed.
UNIT 6.2 – SOUND ENERGY (15 periods)		
<i>Topics</i>	<i>General Objectives</i>	<i>Specific Objectives</i>
The sounds we hear	6.2.1 be aware of the nature, characteristics and properties of sound. 6.2.2 be aware of the propagation of sound.	6.2.1.1 demonstrate the production of sound from various instruments. 6.2.2.1 state how sound travels. 6.2.2.2 demonstrate how a longitudinal wave travels using a coil spring. 6.2.2.3 define wavelength, frequency and amplitude. 6.2.2.4 demonstrate the production of low and high notes. 6.2.2.5 relate pitch to frequency of vibration. 6.2.2.6 relate loudness to amplitude of vibration. 6.2.2.7 demonstrate reflection of sound (echoes). 6.2.2.8 demonstrate that sound needs a medium for transmission. 6.2.2.9 state the relative speeds of sound in different media. 6.2.2.10 compare the speed of sound to the speed of light in air.(compare lightning to thunder).

The ear	6.2.3 be aware of the simple structure of the ear. 6.2.4 be aware of the body's ability to detect and respond to sound.	6.2.3.1 state parts of the ear that enable hearing. 6.2.3.2 describe the functions of parts of the ear that enable hearing. 6.2.4.1 explain how sound waves travel into the ear through the different media. 6.2.4.2 describe how we hear.
Ear defects and deafness	6.2.5 be aware of the general malfunction of the ear and how to cope with it.	6.2.5.1 state the possible causes of deafness (including noise pollution, poking ear, diseases). 6.2.5.2 demonstrate how deaf people communicate using sign language/lip reading/hearing aids.
Applications of sound	6.2.6 be aware of applications of sound.	6.2.6.1 state that sound enables us to hear. 6.2.6.2 state uses of sound e.g. scanning by ultrasound.

MODULE 7: HEALTHY LIVING

UNIT 7.1 - PERSONAL HYGIENE (5 periods)

<i>Topics</i>	<i>General Objectives</i>	<i>Specific Objectives</i>
Keeping clean	7.1.1 Acquire knowledge and skills of keeping their bodies, clothes and surroundings clean at all times.	7.1.1.1 explain the importance of personal hygiene. 7.1.1.2 demonstrate aspects of personal hygiene: care of parts of the body (ears, eyes, hair, nails etc.) clothing and surroundings.
Caring for teeth	7.1.2 be aware of the cause of dental diseases.	7.1.2.1 draw and label the following parts of a tooth (enamel, dentine, pulp cavity). 7.1.2.2 state functions of different types of teeth. 7.1.2.3 describe causes of tooth decay and gum disease. 7.1.2.4 demonstrate the action of acid on the tooth. 7.1.2.5 describe prevention of tooth decay and gum disease.

UNIT 7.2 - NUTRITION (10 periods)

<i>Topics</i>	<i>General Objectives</i>	<i>Specific Objectives</i>
Food, nutrients and their sources	7.2.1 be aware of the importance of eating the correct amount, and correct types, of food.	7.2.1.1 list the main food types: energy-giving (fats and carbohydrates), body-building (proteins), protective (vitamins and minerals), "other" (water and fibre). 7.2.1.2 list locally available sources for each food type. 7.2.1.3 conduct tests for glucose, starch, fats and protein. 7.2.1.4 plan a balanced diet. 7.2.1.5 list common deficiency diseases and the associated food lacking from the diet: kwashiorkor, marasmus, vitamins (A, C and D) and minerals (iron, calcium, phosphorus, iodine, fluoride) deficiencies. 7.2.1.6 discuss the dangers of malnutrition (including overeating).

Food poisoning	7.2.2 be aware of the causes and dangers of food poisoning.	7.2.2.1 investigate optimal conditions for fast microbial growth. 7.2.2.2 list common causes of food poisoning. 7.2.2.3 list symptoms of food poisoning.
Preservation, storage and food handling	7.2.3 be aware of the need for food preservation and hygienic food handling.	7.2.3.1 list ways to preserve and store food by killing or excluding micro-organisms, or by slowing their growth. 7.2.3.2 carry out common methods of food preservation. 7.2.3.3 describe safe methods of preparing food.
Digestion	7.2.4 acquire knowledge of how food nutrients are made available to the body tissues.	7.2.4.1 define digestion. 7.2.4.2 describe parts of the digestive system and their functions. 7.2.4.3 state that enzymes are responsible for the digestion of food. 7.2.4.4 state the end-products of starch, protein and fat digestion. 7.2.4.5 carry out an experiment to show how food is absorbed into the blood stream. 7.2.4.6 distinguish between defecation and excretion.
UNIT 7.3 – TRANSPORTING SUBSTANCES IN THE HUMAN BODY (10 periods)		
<i>General Objectives</i>		
What is blood	7.3.1 acquire knowledge of the nature of blood, blood groups and blood transfusions.	7.3.1.1 state functions of blood (transport: food, gases and waste products; temperature control; defence mechanism). 7.3.1.2 observe components of blood on permanent slides using a microscope. 7.3.1.3 state the functions of the components of blood. 7.3.1.4 state blood groups as A, B, AB and O. 7.3.1.5 describe measures taken during blood transfusion (include screening for compatibility, HIV, syphilis, hepatitis B).
The heart and circulatory problems	7.3.2 acquire knowledge of the functions and some of the problems of the circulatory system.	7.3.2.1 describe the heart structure and function (names of valves not necessary). 7.3.2.2 describe the function and structure of the blood vessels: arteries, veins and capillaries. 7.3.2.3 list common diseases of the circulatory system e.g. HIV/AIDS, anaemia, heart attack, and stroke. 7.3.2.4 discuss causes of the diseases of the circulatory system and how they can be prevented. 7.3.2.5 conduct experiments to show the effects of exercise on circulation and breathing.

UNIT 7 - DRUGS (5 periods)		
<i>Topics</i>	<i>General Objectives</i>	<i>Specific Objectives</i>
Drug use, misuse and abuse	7.4.1 be aware of the nature and effects of drugs.	7.4.1.1 define a drug. 7.4.1.2 list drugs which are commonly used and abused. 7.4.1.3 discuss dangers of misuse of medicinal drugs. 7.4.1.4 discuss the dangers of drug abuse. 7.4.1.5 investigate general uses of medicinal plants in their locality. 7.4.1.6 discuss the effects of alcohol. 7.4.1.7 discuss the effects of smoking tobacco (active and passive).

MODULE 8: OUR ENVIRONMENT

UNIT 8 - ENERGY FLOW (15 periods)		
<i>Topics</i>	<i>General Objectives</i>	<i>Specific Objectives</i>
Photosynthesis	8.1.1 understand that energy from the Sun sustains life on Earth and that it can be made available through photosynthesis.	8.1.1.1 describe photosynthesis as the process by which green plants put together carbon dioxide and water in the presence of light to produce carbohydrates. 8.1.1.2 write a word equation for photosynthesis. 8.1.1.3 carry out experiments to investigate the production of oxygen and carbohydrates by green plants. 8.1.1.4 test a green leaf for starch. 8.1.1.5 carry out experiments to investigate the conditions necessary for photosynthesis: carbon dioxide, sunlight and chlorophyll.
Respiration	8.1.2 acquire knowledge of the process of respiration in living organisms.	8.1.2.1 describe respiration as the process through which all living organisms obtain energy. 8.1.2.2 state that respiration occurs in all living cells and distinguish between respiration and breathing. 8.1.2.3 write the word equation for respiration. 8.1.2.4 investigate the levels of carbon dioxide in inhaled air and exhaled air. 8.1.2.5 explain the importance of photosynthesis to all life and state the relationship between photosynthesis and respiration. 8.1.2.6 discuss implications of deforestation.
Transport of food, water and nutrients in plants	8.1.3 acquire knowledge of how substances are transported in plants.	8.1.3.1 describe how plants transport the end-products of photosynthesis. 8.1.3.2 demonstrate how plants transport water and mineral salts. 8.1.3.3 define transpiration. 8.1.3.4 demonstrate conditions that will affect the rate of transpiration.

FORM 2

MODULE 2: MATTER	
UNIT 2.3 AIR (10 periods)	
<i>Topics</i>	<i>Specific Objectives</i>
Components of air	<p>2.3.1 be aware of the components of air.</p> <p>2.3.1.1 state that air is a mixture of gases.</p> <p>2.3.1.2 list major components of air.</p>
Properties of air	<p>2.3.2 gain familiarity with the properties of air.</p> <p>2.3.2.1 carry out investigations to show properties of air: air has weight, air occupies space, air expands when heated, air contracts when cooled, air is an odourless, colourless, tasteless and invisible substance.</p> <p>2.3.2.2 carry out experiments to show that air is necessary for burning.</p>
Preparation, properties and uses of carbon dioxide and oxygen	<p>2.3.3 be aware of the preparation, properties and uses of oxygen and carbon dioxide.</p> <p>2.3.3.1 prepare carbon dioxide by the reaction of acids on carbonates.</p> <p>2.3.3.2 test for carbon dioxide using limewater.</p> <p>2.3.3.3 list the properties of carbon dioxide.</p> <p>2.3.3.4 list common uses of carbon dioxide.</p> <p>2.3.3.5 prepare oxygen (e.g. from hydrogen peroxide and manganese (IV) oxide).</p> <p>2.3.3.6 test for oxygen using a glowing splint.</p> <p>2.3.3.7 list the properties of oxygen.</p> <p>2.3.3.8 list common uses of oxygen.</p> <p>2.3.4 appreciate the importance of oxygen and carbon dioxide to life on Earth.</p>
MODULE 3: FAMILY LIFE EDUCATION	
UNIT 3.4 HUMAN REPRODUCTION (10 periods)	
<i>Topics</i>	<i>Specific Objectives</i>
Pregnancy	<p>3.4.1 acquire basic knowledge on the various stages of pre-natal development.</p> <p>3.4.1.1 describe how fertilisation occurs.</p> <p>3.4.1.2 list signs of pregnancy.</p> <p>3.4.1.3 describe development of the embryo in terms of zygote, ball of cells and foetus.</p> <p>3.4.1.4 state conditions leading to multiple births.</p> <p>3.4.1.5 describe ante-natal care of a pregnant woman which will contribute towards healthy development of the baby. Include desirable behaviour e.g. not smoking, etc.</p> <p>3.4.1.6 describe nutritional needs of a pregnant woman.</p> <p>3.4.1.7 describe the main stages of birth as contraction, breaking of the membranes, dilation of cervix, emergence of baby and expulsion of the placenta.</p>

Child care	3.4.2 acquire knowledge and skills on child care.	<p>3.4.2.1 state why breast feeding is better than bottle feeding.</p> <p>3.4.2.2 describe nutritional needs of a lactating mother and the baby.</p> <p>3.4.2.3 define immunisation.</p> <p>3.4.2.4 list diseases babies are immunised against: Tuberculosis, Measles, Tetanus, Hepatitis-B, Polio, Diphtheria and Whooping cough.</p> <p>3.4.2.5 list the methods of immunisation against these diseases.</p> <p>3.4.2.6 interpret the immunisation schedule.</p>
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MODULE 4: WATER

UNIT 4.2 - WATER AS A UNIVERSAL SOLVENT (15 periods)

Topics		Specific Objectives
		General Objectives
Dissolving	<p>4.2.1 understand that water is a universal solvent.</p> <p>4.2.2 be familiar with concepts of solutes, solvent and solution.</p> <p>4.2.3 develop skill to carry out techniques of making solutions.</p>	<p>4.2.1.1 define the concept "universal" solvent.</p> <p>4.2.1.2 carry out dissolution experiments of substances in water.</p> <p>4.2.2.1 define solute, solvent and solution.</p> <p>4.2.3.1 prepare different concentrations of common solutions in the laboratory (not molarity).</p> <p>4.2.3.2 carry out investigations to distinguish between saturated, unsaturated and supersaturated solutions.</p> <p>4.2.3.3 discuss applications of saturated and supersaturated solutions(drink concentrates).</p> <p>4.2.3.4 list factors affecting solubility.</p> <p>4.2.3.5 demonstrate factors affecting solubility.</p>
Hard and soft water	4.2.4 understand the basic differences between hard and soft water.	<p>4.2.4.1 explain the concepts of "soft" and "hard" water.</p> <p>4.2.4.2 distinguish between soft water and hard water through experimentation.</p> <p>4.2.4.3 state the disadvantages of hard water.</p> <p>4.2.4.4 explain how hard water becomes hard.</p> <p>4.2.4.5 state how hard water can be softened.</p>
Making water safe for use	4.2.5 understand and appreciate the need to make water safe for use.	<p>4.2.5.1 explain the importance of keeping water clean.</p> <p>4.2.5.2 use a microscope to identify some micro-organisms commonly found in dirty water.</p> <p>4.2.5.3 discuss the dangers of drinking contaminated water.</p> <p>4.2.5.6 demonstrate the common methods of making water safe for domestic use.</p> <p>4.2.5.7 describe how towns' and villages' water is purified.</p> <p>4.2.5.8 visit nearby water works to study purification system(if there is one nearby).</p> <p>4.2.5.9 design a method that can be used to desalinate water.</p>

MODULE 5: FORCES

UNIT 5.1: INVESTIGATING FORCES (20 periods)

Topics	General Objectives	Specific Objectives
Types of forces	5.1.1 acquire knowledge of some principles about forces and appreciate the role they play in our everyday life.	5.1.1.1 define force as a push or a pull. 5.1.1.2 demonstrate that where there is a force, it is exerted by one object on another. 5.1.1.3 with the use of diagrams, show the direction of a force acting on an object in familiar simple situations. 5.1.1.4 name different types of forces: gravitational, elastic, magnetic, electrostatic and frictional. 5.1.1.5 describe effects of the following forces: gravitational, elastic, magnetic, electrostatic and frictional.
Effects of forces	5.1.2 be aware of the effect of forces on objects.	5.1.2.1 demonstrate that a force may produce a change in size and shape of a body. 5.1.2.2 state that a force may produce a change in the speed and direction of a body. 5.1.2.3 demonstrate that a force may produce a change in the speed and direction of a body.
Frictional force	5.1.3 be aware of the effect of friction on objects.	5.1.3.1 state that friction is a force which opposes the relative motion between two touching surfaces. 5.1.3.2 demonstrate the effects of friction on the motion of an object. 5.1.3.3 investigate force of friction in fluids. 5.1.3.4 demonstrate ways in which friction can be reduced e.g. wheels, lubrication, ball bearings, streamlining. 5.1.3.5 investigate common practical applications of friction.
Measuring force	5.1.4 be aware of the methods of measuring force. 5.1.5 be aware of the relationship and difference between mass and weight.	5.1.4.1 measure force in Newtons using a forcemeter. 5.1.4.2 make a simple forcemeter and calibrate it. 5.1.5.1 describe the difference between weight and mass. 5.1.5.2 describe the relationship between weight and mass.

MODULE 6: ENERGY

UNIT 6.3: LIGHT ENERGY (15 periods)

Topics	General Objectives	Specific Objectives
Sources	6.3.1 be aware of the sources of light.	6.3.1.1 identify sources of light. 6.3.1.2 distinguish between luminous and non-luminous objects.

<p>Properties of light</p>	<p>6.3.2 be aware of properties of light, reflection and refraction. 6.3.3 be aware of properties of lenses and mirrors.</p>	<p>6.3.2.1 demonstrate reflection in a plane mirror. 6.3.2.2 demonstrate reflection on an uneven surface. 6.3.2.3 identify angles of incidence and reflection and their relationship. 6.3.3.1 observe images formed by plane reflecting surfaces. 6.3.3.2 demonstrate images formed by a curved surfaces((concave and convex mirror). 6.3.3.3 give uses of plane and curved mirrors. 6.3.3.4 demonstrate refraction through water, glass block and prisms. 6.3.3.5 demonstrate refraction by lenses (convex and concave). 6.3.3.6 measure the focal length of converging lenses. 6.3.3.7 state uses of optical instruments (e.g. telescope, binoculars, periscope, hand lens, film projector).</p>
<p>Splitting white light</p>	<p>6.3.4 be aware that white light can be split into light of various colours.</p>	<p>6.3.4.1 state the different colour components of white light. 6.3.4.2 demonstrate the dispersion of light by a prism. 6.3.4.3 describe how a rainbow is formed.</p>
<p>The eye</p>	<p>6.3.5 be aware of the body's ability to detect and respond to light. 6.3.6 be aware of the simple structure and function of the eye.</p>	<p>6.3.5.1 draw the eye and label the following parts: cornea, pupil, iris, lens, ciliary muscles, optic nerve, retina). 6.3.5.2 describe the functions of parts of the eye. 6.3.6.1 describe how we see. 6.3.6.2 demonstrate how the eye lens focuses images on the retina using a screen and convex lens.</p>
<p>Eye defects, blindness and diseases</p>	<p>6.3.7 be aware of types of eye defects and how they can be corrected. 6.3.8 appreciate how blind people communicate.</p>	<p>6.3.7.1 describe eye defects (short sight, long sight and astigmatism) and how they can be corrected. 6.3.7.2 describe colour blindness and its hazards. 6.3.7.3 state the possible causes of blindness. 6.3.7.4 describe causes, signs and treatment of some eye diseases: stye, cataract, conjunctivitis, trachoma. 6.3.8.1 demonstrate how the blind read Braille.</p>
<p>Applications of light</p>	<p>6.3.9 be aware of the various applications of light.</p>	<p>6.3.9.1 state that light enables us to see. 6.3.9.2 identify parts of a simple camera. 6.3.9.3 describe functions of parts of a camera. 6.3.9.4 state the uses of different coloured lights: traffic lights. 6.3.9.5 state how plants respond to light. 6.3.9.6 state the need for light in photosynthesis.</p>

UNIT 6.4 HEAT ENERGY (10 periods)		
<i>Topics</i>	<i>General Objectives</i>	<i>Specific Objectives</i>
Sources and effects of heat	6.4.1 acquire knowledge of heat, its sources and effects.	6.4.1.1 state the different sources of heat. 6.4.1.2 demonstrate expansion and contraction in solids, liquids and gases. 6.4.1.3 identify uses of expansion e.g. bimetallic strip, fire alarm, gas thermostat, thermometers. 6.4.1.4 identify problems of expansion and contraction in every day applications e.g. railway lines, plumbing, electricity cables.
Methods of heat transfer and applications	6.4.2 acquire knowledge of methods of heat transfer and be able to relate these to application in everyday life.	6.4.2.1 state the three methods of heat transfer conduction, convection and radiation. 6.4.2.2 classify substances on the basis of how well they conduct and radiate heat. 6.4.2.3 discuss applications of conduction, convection and radiation in everyday life e.g. solar water heater, car engine cooling system and vacuum flask. 6.4.2.4 identify some practical examples of insulators. 6.4.2.5 conduct experiments to show the effect of insulation on heat loss.
Temperature regulation	6.4.3 be aware of insulation in animals.	6.4.3.1 describe how fat insulates animal. 6.4.3.2 describe how different animals are adapted to keep cool and warm.

MODULE 7: HEALTHY LIVING

UNIT 7.5 COMMUNICABLE DISEASES (10 periods)		
<i>Topics</i>	<i>General Objectives</i>	<i>Specific Objectives</i>
Causes of infectious diseases	7.5.1 be aware of the causes of common communicable diseases.	7.5.1.1 describe the difference between communicable diseases and non communicable 7.5.1.2 list communicable diseases e.g. tuberculosis, bilharzia, malaria, polio, flu, sexually transmitted diseases (syphilis, gonorrhoea, HIV/AIDS), intestinal infections, ringworm. 7.5.1.3 classify communicable diseases using common causative agents (bacteria, virus, fungi).
How infections are spread	7.5.2 be aware of transmission routes of common communicable diseases.	7.5.2.1 list vectors of communicable diseases (food, water, air, direct contact, animal).
Preventing infections	7.5.3 be aware of how common communicable diseases can be prevented.	7.5.3.1 list methods of prevention and/or controlling communicable diseases. 7.5.3.2 discuss life cycles of housefly, mosquito, bilharzia fluke and how they can be controlled. 7.5.3.3 analyse national statistics for communicable diseases.

MODULE 8: OUR ENVIRONMENT

UNIT 8.2: ECOSYSTEMS (15 periods)

Topics	General Objectives	Specific Objectives
Characteristics of ecosystems	8.2.1 understand the interaction of living things with each other and with their environment.	8.2.1.1 describe an ecosystem as consisting of a given habitat and community.. 8.2.1.2 describe characteristics of an ecosystem in terms of living and non living factors 8.2.1.3 study the structure and make up of an ecosystem in their locality. 8.2.1.4 infer the relationships among the organisms found in that ecosystem.
Food chains, food webs, food pyramids, producers and consumers	8.2.2 recognise the importance of plants as food producers.	8.2.2.1 recognise the effect of changing numbers of one species on the other species in a food web. 8.2.2.2 recognise the relationships between producers and consumers 8.2.2.3 describe how energy flows through living things using food chains, food webs and food pyramids. 8.2.2.4 construct a food pyramid to show the numbers of organisms consumed at each feeding level. 8.2.2.5 describe how changes in food supply, predation, overgrazing will cause changes in population size of animals and plants. 8.2.2.6 describe how pollutants may be concentrated through food chains and food webs.
Adaptation	8.2.3 understand adaptation of organisms to their environments.	8.2.3.1 describe how plant and animal species adapt to their environment. 8.2.3.2 debate the impact of people's activities on ecosystems.
Nutrient cycles	8.2.4 recognise the interdependence of living organisms through nutrient cycles.	8.2.4.1 describe the nitrogen cycle in terms of nitrogen fixation by root nodule and lightning, animal and plant nutrition, nitrogen in the air and denitrification. 8.2.4.2 describe the carbon cycle in terms of animal and plant nutrition, combustion, respiration, decomposition and formation of fossil fuels.

UNIT 8.3: SEXUAL REPRODUCTION IN FLOWERING PLANTS (10 periods)

Topics	General Objectives	Specific Objectives
Reproductive parts of a flower	8.3.1 acquire knowledge of reproductive parts of a flowering plant.	8.3.1.1 observe, draw and label the reproductive parts of a flower. 8.3.1.2 describe the functions of the reproductive parts of a flower.
Pollination and fertilisation	8.3.2 acquire knowledge of the processes pollination and fertilisation.	8.3.2.1 collect and examine pollen grains. 8.3.2.2 describe the process of pollination. 8.3.2.3 describe fertilisation in plants. 8.3.2.4 describe changes in a flower leading to seed and fruit formation. 8.3.2.5 observe the different parts of a seed. 8.3.2.6 distinguish between wind and insect pollinated flowers.
Seed dispersal	8.3.3 understand the importance of seed dispersal.	8.3.3.1 describe fruit and seed dispersal by wind, animals and self-mechanisms. 8.3.3.2 collect fruits and seeds and find out how their structure helps in their dispersal. 8.3.3.3 classify fruits and seeds into groups according to their methods of dispersal.

MODULE 9: COMMUNICATION

UNIT 9.1 - COMMUNICATION IN ANIMALS (10 periods)

Topics	General Objectives	Specific Objectives
Communicating by using senses	9.1.1 acquire knowledge about the use of senses in communication in animals.	9.1.1.1 explain communication as sending, receiving messages and responding to impulses. 9.1.1.2 demonstrate ways of communication to include listening, speaking, reading, writing, seeing, tasting, touching and smelling. 9.1.1.3 list the sense organs and stimuli they respond to.
Nervous system	9.1.2 acquire knowledge of how the nervous system responds to stimuli in the environment..	9.1.2.1 describe how the nervous system works 9.1.2.2 distinguish between a voluntary and involuntary action 9.1.2.3 demonstrate simple reflex action
Hormones	9.1.3 understand hormones as chemical messengers	9.1.3.1 describe hormones as chemical substances that control the activities of one or more specific organ(s). 9.1.3.2 list some hormones and their sources (insulin and adrenaline). 9.1.3.3 describe the function of each hormone listed above. 9.1.3.4 collect and interpret data on number of cases of diabetes in their locality.

MODULE 10: SCIENCE IN THE HOME

UNIT 10.1 - THE HOUSE AND SURROUNDINGS (5 periods)

Topics	General Objectives	Specific Objectives
Building materials	10.1.1 be aware of the need for house design appropriate to local conditions and available building materials.	10.1.1.1 list building materials available in your area/location. 10.1.1.2 describe properties (good and bad) of selected house-building materials (both traditional and modern) and their uses.
Ventilation	10.1.2 be aware of the need for ventilation in the house and how to achieve it.	10.1.2.1 describe air movement within a building. 10.1.2.2 describe the effects of poor ventilation. 10.1.2.3 describe how good house design achieves good ventilation.
Insulation	10.1.3 be aware of the need for insulation.	10.1.3.1 investigate how window position, roof overhang and house colour can be used to control the heat radiation in and out of the house. 10.1.3.2 design experiments to assess the suitability of materials for insulation.
Sanitation	10.1.4 be aware of the need for domestic hygiene.	10.1.4.1 explain why sewage must be properly disposed of. 10.1.4.2 describe hygienic ways of disposing sewage. 10.1.4.3 describe methods of disposing domestic refuse.

FORM 3

MODULE 2: MATTER	
UNIT 2.4: THE BUILDING BLOCKS OF MATTER (15 periods)	
Topics	General Objectives
Atoms, elements, mixtures, molecules and compounds	<p>2.4.1 be familiar with the building blocks of matter.</p> <p>2.4.1.1 define the terms atoms, elements, molecules, compounds and mixtures.</p> <p>2.4.1.2 describe the basic structure of an atom (arrangement of electrons in shells not necessary).</p> <p>2.4.1.3 state that names of elements are represented by symbols (use examples of common elements).</p> <p>2.4.1.4 give some examples of common elements in living and non-living matter (carbon, hydrogen, oxygen, silicon, aluminium).</p> <p>2.4.1.5 give some examples of common compounds and the elements they are composed of (water, sugar, sodium chloride, carbon dioxide).</p> <p>2.4.1.6 distinguish between compounds and mixtures.</p> <p>2.4.1.7 carry out an experiment to determine boiling/melting points of a compound.</p> <p>2.4.1.8 plot and interpret a heating curve.</p> <p>2.4.1.9 carry out an experiment to verify that boiling points do not depend on the rate of heating.</p> <p>2.4.1.10 carry out an experiment to determine the effect of impurities on melting point and boiling points of selected substances.</p>
Physical and chemical changes	<p>2.4.2 understand the principles of physical and chemical changes.</p> <p>2.4.3 gain experimental knowledge of basic purification techniques.</p>
Purification techniques	<p>2.4.3.1 carry out selected purification techniques e.g. filtration, evaporation, distillation and chromatography.</p> <p>2.4.3.2 explain the differences between distillation and evaporation.</p> <p>2.4.3.3 state some application examples of separation methods e.g. water purification, crude oil distillation, distillation of fermented solutions.</p>
Chemical reactions	<p>2.4.4 have a basic knowledge of chemical reactions.</p> <p>2.4.4.1 experiment with chemical reactions.</p> <p>2.4.4.2 list characteristic visible signs for a chemical reaction.</p> <p>2.4.4.3 investigate factors affecting rates of reactions.</p> <p>2.4.4.4 correlate the terms reactants and products with beginning and end of a reaction.</p>

UNIT 25 ACIDS AND BASES (10 periods)

Topics	General Objectives	Specific Objectives
Properties and examples of acids and bases	2.5.1 acquire basic knowledge of acids, bases and salts.	2.5.1.1 define acid, base and alkali. 2.5.1.2 give some examples of acids, bases and alkalis (e.g. hydrochloric acid, sulphuric acid, nitric acid, citric acid, sodium hydroxide, ammonia, calcium hydroxide). 2.5.1.3 describe the common properties of acids, bases and alkalis. 2.5.1.4 define an acid-alkali indicator. 2.5.1.5 prepare acid-alkali indicators from plant material. 2.5.1.6 test for acids and alkalis using litmus paper. 2.5.1.7 state the colour of universal indicator when placed in an acidic, neutral or alkaline solutions. 2.5.1.8 describe the corrosive and hazardous effects of concentrated acids and alkalis.
Chemical reactions of acids and bases	2.5.2 be familiar with common chemical reactions of acids and of bases.	2.5.2.1 carry out neutralisation reactions between acids and alkalis. 2.5.2.2 carry out reactions of acids with carbonates and with metals. 2.5.2.3 name products of the above reactions. 2.5.2.4 test for hydrogen. 2.5.2.5 write word equations for reactions of acids with alkalis, carbonates and metals.

UNIT 26 METALS AND NON-METALS (10 periods)

Topics	General Objectives	Specific Objectives
Properties, uses and examples	2.6.1 be familiar with the properties and uses of metals and non-metals..	2.6.1.1 state the physical and chemical properties of metals and non-metals. 2.6.1.2 list some examples and uses of metals and non-metals.
Reactions of metals with non-metals	2.6.2 study the reactions of metals with non-metals.	2.6.2.1 carry out investigations involving the reactions of selected metals with oxygen, acids, water and sulphur. 2.6.2.2 describe how rusting occurs. 2.6.2.3 demonstrate how rusting occurs. 2.6.2.4 describe methods of preventing rusting.
Rocks, minerals and ores	2.6.3 acquire knowledge of the Earth's resources.	2.6.3.1 classify rocks as igneous, metamorphic and sedimentary. 2.6.3.2 distinguish between rocks, minerals and ores.
Mining	2.6.4 be familiar with the extraction of metals from minerals mined in Botswana.	2.6.4.1 describe how iron is extracted from its ores. 2.6.4.2 describe how copper is extracted from its ore. 2.6.4.3 visit some mining sites.

MODULE 5: FORCES

UNIT 5.2: MACHINES (10 periods)

<i>Topics</i>	<i>General Objectives</i>	<i>Specific Objectives</i>
Simple machines	5.2.1 acquire knowledge of some principles of simple machines and their applications in everyday life.	5.2.1.1 define a machine as a device which enables work to be done easily. 5.2.1.2 observe simple machines in operation: levers, inclined plane, wheels, pulleys and gears. 5.2.1.3 demonstrate an understanding of how levers and inclined planes exert a magnified or reduced force. 5.2.1.4 discuss applications of simple machines in everyday life.
Skeletal system	5.2.2 acquire knowledge of how the skeleton and muscles bring about movement in animals.	5.2.2.1 list the main functions of a human skeleton. 5.2.2.2 describe the action of the skeleton, joints and muscles to bring about movement. 5.2.2.3 demonstrate an understanding that the arm is a lever. 5.2.2.4 discuss the effects of bad posture on various parts of the body. 5.2.2.5 explain why it is important to have correct posture.

MODULE 6: ENERGY

UNIT 6.5: ELECTRICAL ENERGY

<i>Topics</i>	<i>General Objectives</i>	<i>Specific Objectives</i>
Sources of electricity	6.5.1 be aware of different ways of producing electricity.	6.5.1.1 identify sources of electrical energy: solar cells/ dynamos/dry cell/car battery etc. 6.5.1.2 discuss energy changes at a power station (hydroelectric, thermal, petrol/diesel generator).
Circuits, voltage, current and resistance	6.5.2 acquire basic knowledge about the nature and flow of electricity.	6.5.2.1 define an electric current as a flow of electrons. 6.5.2.2 draw circuit diagrams using symbols of cell, wire, bulb, switch, fuse, ammeter, voltmeter, resistor). 6.5.2.3 construct simple circuits. 6.5.2.4 demonstrate that a complete/closed circuit is required for current to flow. 6.5.2.5 demonstrate the difference between a series and parallel circuit. 6.5.2.6 use an ammeter to measure current in series and parallel circuits. 6.5.2.7 use a voltmeter to measure voltage in series and parallel circuits. 6.5.2.8 demonstrate electrical resistance. 6.5.2.9 identify common electrical conductors and insulators.



Effects of electricity	6.5.3 be aware that electricity has a heating, chemical and magnetic effect.	<p>6.5.3.1 demonstrate the heating effect of electricity.</p> <p>6.5.3.2 list some applications of the heating effect of electricity.</p> <p>6.5.3.3 demonstrate the magnetic effect of electric current.</p> <p>6.5.3.4 list some applications of the magnetic effect of electricity.</p> <p>6.5.3.5 demonstrate the chemical effect of electricity.</p> <p>6.5.3.6 list some applications for the chemicals effects of electricity: electrolysis.</p>
Using electrical appliances and power consumption	6.5.4 be aware of the possible uses of electricity.	<p>6.5.4.1 explain the role of the earth wire, fuse and trip switch.</p> <p>6.5.4.2 wire a mains plug correctly.</p> <p>6.5.4.3 demonstrate a short circuit.</p> <p>6.5.4.4 state the hazards of damaged insulation, overheating of cables, damped conditions.</p> <p>6.5.4.5 relate power/wattage to cost of electricity.</p> <p>6.5.4.6 describe how mains electricity is distributed.</p> <p>6.5.4.7 state the safety precautions to be taken to prevent damage during thunderstorms.</p>

MODULE 8: OUR ENVIRONMENT

UNIT 8.4 – MANAGING NATURAL RESOURCES (15 periods)

<i>Topics</i>	<i>General Objectives</i>	<i>Specific Objectives</i>
Conserving natural resources	8.4.1 recognise the need to conserve natural resources in Botswana and how to achieve this.	<p>8.4.1.1 define "natural resource".</p> <p>8.4.1.2 list important natural resources – water, minerals, wildlife, soil, energy, people.</p> <p>8.4.1.3 describe the importance of conserving these to the local and national economy.</p> <p>8.4.1.4 investigate ways we can conserve resources.</p> <p>8.4.1.5 define "recycling".</p> <p>8.4.1.6 discuss the benefits of recycling.</p>
Pollution	8.4.2 be aware of types, sources and prevention of pollution.	<p>8.4.2.1 explain what is meant by pollution.</p> <p>8.4.2.2 describe types of pollution (air, water and land).</p> <p>8.4.2.3 describe common sources of pollution (agricultural, domestic and industrial).</p> <p>8.4.2.4 list the effect of chemicals on living systems (used batteries, chemicals from industry and non-biodegradable substances).</p> <p>8.4.2.5 explain the problems caused by water pollution and how it affects plant and animal life (human waste, poisonous industrial pollution, excess nutrients).</p> <p>8.4.2.6 investigate effects of air pollution on our health.</p> <p>8.4.2.7 investigate through research the action of a pollutant in their locality.</p> <p>8.4.2.8 investigate measures taken to prevent pollution in their locality.</p> <p>8.4.2.9 describe the effects of pollutants on the ozone layer.</p> <p>8.4.2.10 describe the causes of the greenhouse effect and its consequences (e.g. global warming).</p>

UNIT 8.5 - SOLAR SYSTEMS (5 periods)		
<i>Topics</i>	<i>General Objectives</i>	<i>Specific Objectives</i>
Stars and planets	8.5.1 be aware of existence of other heavenly bodies.	8.5.1.1 describe the Sun as a star and the centre (and ultimate energy source) of our solar system. 8.5.1.2 list the nine planets of the solar system, in order of distance from the Sun.
Motion of planets	8.5.2 be aware of the motions of the planets around the Sun.	8.5.2.1 describe the motion of the Earth around the Sun. 8.5.2.2 explain the annual change of seasons. 8.5.2.3 describe the Earth's rotation about its axis.
The moon	8.5.3 be aware of the motion of the moon around the Earth.	8.5.3.1 describe the moon's revolution around the Earth. 8.5.3.2 explain the phases of the moon in terms of its position relative to the Earth and Sun (full moon, half moon etc.).

MODULE 9: COMMUNICATION

UNIT 9.2 - ELECTRONIC COMMUNICATION (15 periods)		
<i>Topics</i>	<i>General Objectives</i>	<i>Specific Objectives</i>
Electronic devices	9.2.1 be aware of electronic devices used for communication.	9.2.1.1 identify electronic devices used for communication. 9.2.1.2 distinguish between devices for transmission and storage of information (telephone, radio, television, cassettes, film, discs etc.). 9.2.1.3 list the main parts necessary for telephone communication (transmitter and receiver) 9.2.1.4 state the functions of the transmitter and receiver in a telephone. 9.2.1.5 list the different ways in which telephone signals can be transmitted (e.g. by cables, optical fibres, microwaves). 9.2.1.6 describe the components necessary for radio and television communication (transmitter and receiver). 9.2.1.7 state functions of components necessary for radio and television communication (transmitter and receiver). 9.2.1.8 state the advantages and disadvantages of radio and television as modes of communication. 9.2.1.9 identify major components of a computer: monitor, keyboard, drive, Central Processing Unit. 9.2.1.10 demonstrate that a computer is used for storing information, retrieving and selecting it rapidly. 9.2.1.11 carry out simple specified instructions using a computer.

MODULE 10: SCIENCE IN THE HOME

UNIT 10.2 - ENERGY IN THE HOME (10 periods)

Topics	General Objectives	Specific Objectives
Types and sources of energy used in the home	10.2.1 be aware of the forms of energy used in the home and their sources.	<p>10.2.1.1 identify types of energy used in the home: chemical, electrical, heat and light energy.</p> <p>10.2.1.2 identify sources of electrical energy as mains, generators, batteries, solar cells.</p> <p>10.2.1.3 identify sources of chemical energy in the home: food, fuels (coal and oil).</p> <p>10.2.1.4 identify sources of heat and light energy in the home: coal, wood, paraffin, electricity, dung and other relevant examples.</p> <p>10.2.1.5 discuss the availability of forms and sources of energy with reference to location and cost (financial and environmental).</p>
Using energy sources safely	10.2.2 be aware of common safety precautions when handling energy sources in the home.	<p>10.2.2.1 discuss safety precautions to be taken when using electricity.</p> <p>10.2.2.2 make simple diagnoses of faults in electrical appliances.</p> <p>10.2.2.3 correctly identify proper bulbs and fuses to replace faulty ones.</p> <p>10.2.2.4 discuss safety precautions and dangers involved with the burning of fuels: proper ventilation, poisonous nature of carbon monoxide.</p>

UNIT 10.3 - CHEMICALS IN THE HOME (10 periods)

Topics	General Objectives	Specific Objectives
Common household chemicals	10.3.1 be aware of common household chemicals.	<p>10.3.1.1 give examples of some household chemicals and their uses.</p> <p>10.3.1.2 classify household chemicals as acidic, alkaline or neutral.</p> <p>10.3.1.3 describe safe storage of chemicals.</p> <p>10.3.1.4 interpret symbols and/or instructions on labels.</p> <p>10.3.1.5 describe action to be taken in emergencies involving common chemicals in the home e.g. poisoning.</p>
Simple household chemical reactions	10.3.2 acquire knowledge of some simple household chemical reactions.	<p>10.3.2.1 describe traditional ways of making soap.</p> <p>10.3.2.2 make a simple soap in the laboratory.</p> <p>10.3.2.3 write the word equation that summarises the reaction for soap production.</p> <p>10.3.2.4 name sodium carbonate (washing soda) as chemical used for softening hard water.</p> <p>10.3.2.5 describe the processes involved in making dough raise (significance of raising agents).</p> <p>10.3.2.6 discuss the effects of chemical technology in improving food production (use of fertilisers, pesticides).</p>

APPENDIX 13

ABBREVIATIONS

a) The following abbreviations which are arranged in alphabetical order are used in this work.

CDU: Curriculum Development Unit.

CJSS: Community Junior Secondary School;

JSEIP: Junior Secondary Education Improvement Project;

NCE-1976: National Commission on Education for 1976;

NCE-1993: National Commission on Education for 1993;

OECD: Organisation for Economic Co-operation and Development;

PSLE: Primary School Leaving Examinations

TSM: Teaching Service Management;

TTD: Teacher Training and Development;

USAID: United States Agency for International Development.

c) The following four abbreviations for scientific units were also used.

i) Two are units of volume and they are:

ml which stands for millilitre;

cm³ which stands for cubic centimetres.

ii) One unit of mass is used. It is **Kg** which stands for Kilogram;

iii) **°C** stands for degree Celsius and it is a unit of temperature.

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